NATURE

No. 4409 SATURDAY, MAY 1, 1954 Vol. 173

CONTENTS

	Page
Scientific Research and Industry in Britain	787
Social Conditions and the Development of Science. By Prof. Herbert Dingle	791
Archæology of Lachish in the Near East. By Prof. M. E. L. Mallowan	792
Study of Management. By T. H. Hawkins	792
Information Theory made Easy. By Dr. D. Gabor	793
The British Fundamental Gravity Station : New Site at the National Physical Laboratory, Teddington, Middlesex	794
Pithecanthropus, *Meganthropus* and the Australopithecinae. By Prof. G. H. R. von Koenigswald	795
Department of Scientific and Industrial Research: Report for the Year 1952–53	797
Obituaries:	
Dr. G. P. Bidder. By Dr. C. F. A. Pantin, F.R.S.	802
Mr. S. F. Ashby. By Dr. S. P. Wiltshire	802
Mr. J. G. R. Elbo	803
News and Views	803
Extension to the Metallurgy Division of the National Physical Laboratory. By H. A. Sloman	808
Unimolecular Gas Reactions	809
Scientific and Technical Documentation in Turkey. By Mrs. Lucia Moholy	811
Laterites and Bauxites of Antrim. By Prof. A. Holmes, F.R.S.	812
Carnegie Trust for the Universities of Scotland: Annual Report for 1952–53	812
Averages of Bright Sunshine and Temperature for Great Britain and Northern Ireland	813
Corpuscular Eclipse in the F_2-Layer and its Association with Solar Flares and M-Regions. By Dr. Prabhat K. Sen Gupta and S. N. Mitra	814
Vascular Plants Common to the Arctic and the British Isles. By Dr. Nicholas Polunin	816
Letters to the Editors:	
Radio Emission from the Perseus Cluster.—J. E. Baldwin and B. Elsmore	818
Intensities of Discrete Radio Sources in Cygnus and Cassiopeia at 22·6 Mc./s.—J. S Hey and V. A. Hughes	819
Temperature Distribution in an Electrically Heated Filament.—Sir K. S. Krishnan, F.R.S., and S. C. Jain	820
A New Technique for investigating Surface Flow in Metal-working Processes.—J. M. Capus and M. G. Cockcroft	821
Refractive Index of Concentrated Protein Solutions.—Dr. R. Barer and S. Tkaczyk	821
Cobalt as a Carcinogen.—J. C. Heath	822
Soluble Feather Keratin.—A. M. Woodin	823
Physical State of Deoxyribonucleic Acid in Rat Thymus Homogenates.—Dr. K. V. Shooter	824
Mutagenic Activity of Ethylenimine Picrate.—Dr. Giuseppe Cardinali	825
Denitrification of Nitrite by a Species of *Achromobacter*.—Jean B. Youatt	826
Effect of DDT on the Metabolism of Khapli Wheat Seedlings.—Dr. F. R. Forsyth	827
Development of the Syncytial Endosperm of *Cocos nucifera*.—Prof. Victor M. Cutter, jun., and Bessie Freeman	827
Control of Mitotic Activity.—D. G. Rowlands	828
Chemical Composition of the Cell Wall of *Coccidioides immitis*.—Dr. F. Blank and Ruth C. Burke	829
A Cyanocobalamin–Protein Complex from Sow's Milk and Desiccated Pig Stomach.—Margaret E. Gregory and E. S. Holdsworth	830
Odour and Chemical Constitution.—R. H. Wright; Dr. G. Malcolm Dyson	831
Effect of Flight on Behaviour of *Aphis fabae* Scop.—Bruce Johnson	831
The Marshes of the Medway Estuary in Romano-British Times.—J. P. T. Burchell	832
Zoological Nomenclature.—Francis Hemming, C.M.G., C.B.E.	832

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

SCIENTIFIC RESEARCH AND INDUSTRY IN BRITAIN

THE deepening anxiety which marked the two preceding reports of the Advisory Council for Scientific and Industrial Research is appreciably diminished in the report of the Advisory Council for 1952–53, a survey of which appears elsewhere in this issue (p. 797). Difficulties arising from the exiguity of current resources are again recorded, and it is once more apparent that the nation's economic development has been hindered by restrictions imposed upon the activities of the Department of Scientific and Industrial Research during recent years which retarded its plans for the development, for example, of the Hydraulics Research Station, the Water Pollution Research Laboratory, and the Mechanical Engineering Research Organization. The Advisory Council does not recapitulate these frustrations, nor does it pretend that the new arrangements for the five years beginning April 1, 1954, announced on November 27, 1953, will necessarily mean the end of all difficulties. The broad effect of those arrangements will be to bring the Department's post-war plans nearly to completion by 1959, thirteen years after they were originally approved in 1946. Further, the Advisory Council understands that it may now advise on the future activities of the Department on a basis essentially that for which it pressed in its report for 1950–51 ; the provision which allows it to carry over unspent balances from one year to another gives it the flexibility which it has repeatedly stressed and which had already received strong support in debates in Parliament.

None the less, the increase in expenditure proposed in the estimates for 1953–54 and for 1954–55 is not large, either in relation to the Department's net expenditure of £5·2 million in 1952–53, or to the national expenditure as a whole. Even in 1959, the net annual resources of the Department are only expected to exceed £6 million very slightly, whereas in 1951 the total expenditure on industrial research and development was estimated in a recent debate in the House of Commons as £268 million, of which probably about £70 million was on civilian research. A recent survey made by the Harvard Business School estimated that industry in the United States spent in that year 2,500 million dollars on research and planned to increase this to more than 3,000 million in 1953.

Thus, the fact that the Advisory Council considers that the new arrangements afford firm ground on which to advise how best to allocate the resources it expects to be available and on which to base forward policy with reasonable assurance that recommendations will not be stultified by lack of means for carrying them to fulfilment, cannot be taken to imply that the resources at the disposal of the Department are adequate for the discharge of the responsibilities which are appropriately laid upon it. On the contrary, the new arrangements make the more urgent and imperative a continuing review of the functions of the Department and the resources at its disposal in relation to the research organization

of Great Britain as a whole, and the resources available to meet the needs of scientific and industrial research and development in all the varied fields of defence, economic development and welfare. That need is well brought out in the present report, for the Advisory Council recognizes very clearly the dynamic character of some of the Department's activities, such as those of the National Physical Laboratory, with the consequent budding off of new sections from time to time. Such changes, moreover, need not necessarily be solely within the Department. They could equally lead to the shedding of responsibilities, as may well follow from one development specifically noted in the report—the formation of companies, analogous to the National Research Development Corporation, to which particular research associations can transfer their responsibilities for economic development of their inventions or discoveries.

In another field, the educational responsibilities of the research associations are assuming an importance, particularly in relation to technological education, which may well render desirable some assessment of the position of the research associations in relation to the expansion of higher technological education apart from their contribution to research, and consideration of the resources to be apportioned to that field. This aspect of the work of the research associations derives its importance at least in part from their place in furthering the more effective utilization of existing knowledge as distinct from the acquisition of new knowledge. Much stress has been laid in recent years on the value of the liaison work of the research associations in furthering the exploitation of science by industry. This work receives special emphasis in the current report, which directs particular attention to the work in this connexion of the Intelligence and Information Division in the headquarters office of the Department.

On the research side, the report brings out more clearly than preceding reports the magnitude of the assistance which the Department is rendering to the universities through its grants for special investigations. Outside the field of nuclear physics, much the largest of these grants is the £230,000 over four years to the University of Manchester for the construction and running costs of the radio-telescope at Jodrell Bank; but grants towards capital and maintenance costs for nuclear physics in universities of the United Kingdom during the quinquennium 1952–57 exceed two and a quarter million pounds. This figure looks small enough against the estimates for the Department of Atomic Research, the £53 million of which for 1954–55 include £4 million on civil research and development and £1·8 million for work for the Department by industry and the universities, as does the quarter of a million pounds or so awarded in grants to students and others in the university budgets; but nevertheless, the contribution of the Department is sufficiently large to indicate the repercussions which could flow from sudden curtailment or reorientation of its activities. Moreover, with the formation of the European Organization for Nuclear Research, the Department will be the medium for official relations with the Organization, and will be responsible for co-ordinating United Kingdom policy on the scientific and administrative questions involved. The United Kingdom's contribution to the budget of the Organization is to be borne on the Department's Vote, and is expected to average £350,000 a year during the seven years while its laboratory is being built, and thereafter some £180,000 a year. In the 1954–55 estimates for the Department, £360,000 is provided for this purpose.

This new interest of the Department indicates, in a minor way, the soundness of the Government's decision to place the major responsibility for the oversight of the development of atomic energy, and particularly for seeing that proper account is taken of the various applications of atomic energy and of nuclear research in the universities, on the Lord President of the Council. The magnitude of these responsibilities for the wise apportionment of the limited resources of Britain in scientific and industrial research and development is clear from the present report, quite apart from those additional responsibilities which the Atomic Energy Corporation Bill will place upon him. Ultimately, with the advice of the Advisory Council for Scientific Policy, he is responsible for the general co-ordination of research and development activities on which the sum of almost £200 million, according to the Civil Estimates, is to be expended in 1954–55. This sum, moreover, does not include any allocation from the Vote for the Atomic Energy Corporation, but it does include some £18 million from the Navy Estimates and £550,000 from the Air Estimates (£315,000 for meteorological research and £235,000 for medical research out of the £748 million provided for production and research in the Defence budget).

To get the exact perspective in which to assess the importance of the Department of Scientific and Industrial Research, it must be emphasized that, even were it possible to obtain an exact figure for the nation's expenditure on scientific and industrial research, we would have still to take account of the Department's contribution in the field of education and also in that of intelligence and in furthering the exchange of information and the use of existing knowledge by industry. When regard is had to all these functions, all of which to some extent fall within the scope of the Lord President's Office, the provision of only £13,300 for that Office in the Civil Estimates suggests that it is under-staffed and ill-provided with the means for securing that the national effort in these fields is kept in balance and fully concerted.

Considering first the £6,267,210 provided for the Department in 1954–55 from the point of view of research, it must be remembered that this increase of £578,379 includes £360,000 for European nuclear research. It also includes £114,500 for American Aid – Technical Assistance Schemes and £124,400 for the promotion of productivity in the same way, part of which is a contribution to the third function of the Department rather than to research. Some £221,050 is for research to be carried out extra-departmentally, and an additional £91,500 is pro-

vided for the research associations, bringing the total annual income of these associations within sight of £5 million. It should be remembered, however, that the Ministry of Supply alone provides more than £98 million for research and development by industry and the universities, etc., and that the expenditure of the Department's various stations has to be considered against expenditures on research of other Government departments in the same field: the quarter of a million pounds expended on fuel research, for example, must be viewed against the £879,900 expended on research and development by the Ministry of Fuel and Power. Nor does this latter figure take account of any expenditure on research by the nationalized industries themselves.

Such expenditure falls outside the £200 million for research and development shown in the Civil Estimates, as does any income which the universities and colleges receive over and above the £27,932,500 provided in the Civil Estimates for 1954–55. There is no estimate available of the total expenditure of the universities on research; but, at least outside the one field of nuclear research, the grants from the Department of Scientific and Industrial Research cannot play any very substantial part. Their importance probably lies less in their magnitude than in contributing to the furtherance of investigations in neglected fields of decisive national importance.

That could equally be true of the Department's contributions in research generally, both in the applied and the fundamental fields. In magnitude its efforts are small compared with what is done elsewhere: with wise direction their importance can be out of all proportion. This consideration, with the fact that neither such surveys of the work of the research associations as the Advisory Council for Scientific and Industrial Research has made, nor the survey of industry and science in the Greater Manchester area carried out by the Manchester Joint Research Council, have brought to light any evidence of badly misdirected work or poor selection of objectives, endorse the value of the provision for continuity of work which the new financial flexibility of the Department makes possible.

The total expenditure of the Department is probably less than ten per cent of the expenditure on industrial research in Great Britain, though its proportion to the expenditure on scientific research, apart from nuclear research, may well be higher. Expenditure on fundamental research in the United Kingdom was estimated in 1951 as no more than £1·5 million. There seems to be no reason, moreover, in the light of the survey made by the Manchester Joint Research Council, for supposing that scientific and technical man-power is being used wastefully, though the Department's educational activities could well contribute towards increasing the efficiency of utilization of our resources in scientific and technical man-power. Here, however, it is even more difficult to assess the magnitude of the Department's contribution, particularly as that made through the research associations may well become even more important than its system of maintenance grants. These grants were increased from October 1, 1953, and the thousand or more current grants represent a valuable contribution to the training of scientific and technical man-power.

While the value of the research associations in relation to the training of technical man-power for industry has only come to be recognized fully in recent years, the Conference held last November showed that the importance of their contribution to the expansion of higher technological education is now widely appreciated. Means have still to be formulated for securing that this contribution is fully effective, and on this point the Advisory Council may well comment in a subsequent report. It should also be explored by the Advisory Council on Scientific Policy in its inquiries into the development of technological education; and it would appear possible that the system of maintenance allowances might be used, among other measures, to alleviate the serious shortage of science teachers which is endangering the future supply of scientists and technologists in Britain.

In its present report, however, the Advisory Council is more concerned with the intelligence functions of the Department and its contribution to the more effective exploitation of science by industry. Little information is available as to the resources deployed by the Department for this purpose. Expenditure on headquarters administration, including the Intelligence and Information Division, is only £213,000, and there is no indication of any immediate intention of expanding the Division. Moreover, the effectiveness of the work of such a Division depends largely on the state of the library and information services of the country generally. In this connexion it must be remembered that the Government has shelved the proposals for a Science Centre in London, in spite of the handicap at once imposed by the delay in implementing the scheme for a national library of science and invention supported by the specialized libraries of the learned societies. The Department, it is true, does something to further the improvement of information services through its grant to the Association of Special Libraries and Information Services, and the Director of that Association has pointed out that where the Association's functions touch the activities of the Intelligence and Information Division every care is taken to avoid duplication or overlapping.

That, however, is a small matter compared with the assistance which an adequately housed national reference library of science and technology, linked with regional libraries and the libraries of the learned societies, could render to the functioning of the Intelligence and Information Division or of the library and information services of industry itself. The failure of the Advisory Council, in its reference to this aspect of the Department's activities, to press the Government to reverse the decision regarding the Science Centre is disappointing. Such a Centre, with its interlocked central and specialized libraries, would directly assist in making research results and research facilities widely and effectively known, in ensuring that they are used and applied more quickly by

industry and Government, and that research and development are undertaken on matters of real national importance so that major benefits accrue with increasing speed and efficiency. Those are the prime interests of the Intelligence and Information Division. The Science Centre would do more than provide mechanical means for furthering them. It would supply a meeting place for informal contacts and discussions, which are more important than any mechanical devices for striking out new ideas and formulating creative projects.

The duties of the Intelligence Division, which were redefined in 1950, are considered at some length by the Advisory Council in the present report. The Division's responsibilities for the organization and maintenance of liaison with overseas countries are growing; nevertheless, the national reference library of science and invention, located adjacent to the Department, as contemplated in the scheme for the Science Centre, would materially assist the efficiency of all sections of the Division's work. Apart from maintaining the Headquarters Records, Library and Information Services and undertaking scientific and technical surveys and inquiries as required, the Intelligence Division has more recently taken over responsibility for the publications and publicity work of the Department. Moreover, it is not only expected to keep watch on scientific progress and direct attention to advances that may be capable of industrial application: by maintaining touch with current economic and sociological affairs and Government policy in these fields, it is expected to ensure that the Department is kept informed of needs, and that the attention of Government Departments, and especially the central economic staff, is directed to the implications of scientific and technical advances.

Consideration merely of those aspects of the Division's work which are specially mentioned by the Advisory Council in this report suggests that to implement the work of this Division on the scale desirable in the national interest could absorb well-nigh the whole sum at present expended on headquarters administration and a large proportion of the half-million or more pounds by which the Department's budget is expected to increase during the next few years. The investigations for which the Division has been responsible during the past two years in regard to the conservation, and substitution, of raw materials which were either scarce or involved currency difficulties when purchased abroad have already offered savings which probably offset by many times the present expenditure of the Division. The Advisory Council refers, for example, to the discovery of economic uses for waste sulphuric acid, and to an investigation of the technical and economic possibilities of recovering non-ferrous metals from the cinders of pyrites roasting plants, which greatly increased in numbers as a consequence of the recent sulphur shortage. Economic assessments have also been made of long-term trends in the demand and supply of selenium, germanium and vanadium, and the possibilities of increasing supplies by technological improvement have been examined by the Division.

The other aspect of the Division's work stressed by the Advisory Council is that relating to industrial productivity, both in regard to the work of the two joint committees with the Medical Research Council on human relations in industry and that on individual industrial efficiency. A number of research projects have already been placed with universities and research organizations, and the work of the Intelligence Division has clearly contributed much to the selection of the broad programmes of research on which these committees are concentrating their attention. Some of this work is being assisted by grants made available to the Department over the next three years from Conditional Aid funds, and in this context also falls the work of a committee appointed to recommend suitable projects for investigation in production economics and the survey of technological resources and the requirements of industrial firms in the Greater Manchester area carried out by the Manchester Joint Research Council, towards which the Department is contributing a grant of about £3,000.

Both the present report from the Department and that from the Manchester Joint Research Council testify to the continuing value of such inquiries and of this intelligence work and liaison work in general in facilitating the utilization of existing knowledge by industry. Nor does either report warrant any belief that this will be a rapid process, even if the scale of such intelligence work is considerably extended. Such activities clearly lie outside the research functions of the Department as strictly understood; but they are no less important, and it would be well if their cost were more clearly indicated. There are obvious difficulties in indicating that figure precisely, since much work of this type is included in the budgets of the research associations. None the less, an attempt at an approximate figure is desirable, particularly in view of a passage in the account of the work of the Intelligence and Information Division which suggests a tendency to rely on Conditional Aid funds to meet the industrial demand for advisory service and information on such matters as methods and time study, materials handling, etc.

The prominence given to this aspect of the Department's work in this year's report from the Advisory Council is thus welcome. The Advisory Council, in stating that one of its main tasks in the coming year will be to consider how to give effect to the recommendation in the last report from the Advisory Council for Scientific Policy regarding the extension of the use of research and development contracts in the modernization of industry and exploitation of scientific discoveries, again stresses the value of the liaison and advisory services of the research associations. Even if precise figures cannot be given for the educational and information work of the Department, it would seem worth while for the Lord President's office to attempt to offer Parliament a picture of the national expenditure in these varied fields. When the Department's expenditure reaches the anticipated figure of £6 million, much of it will be incurred on objectives which cannot properly be classified as research and should be shown under information or

intelligence, or under university or technological education. Even now the Advisory Council's estimate that the present activities of the research associations amount to about one-tenth of the total research and development activities of civil industry seems rather optimistic. An attempt to show the breakdown of the Department's expenditure not simply by its own Divisions but by such categories as research and development, education, information, liaison and intelligence, would permit a sounder judgment as to whether sufficient effort is being devoted to the latter activities. It is not only in the prosecution of research, but also in training man-power for research and in the provision of information and stimulation of thought that the Department is making an essential contribution to industrial development and the improvement of productivity in Great Britain. Its contribution in these fields has to be judged against the magnitude of the effort which is being made elsewhere in the country, and in the main it should be possible to make the comparison from information available within the organizations for the co-ordination of the activities of which the Lord President of the Council is ultimately responsible. Such an assessment, moreover, is an essential element in the formulation of constructive policy in the field of research and development, in technological education, and in the provision of adequate means for the flow of information. The underlying questions and the appropriate means by which policy is to be implemented should now be very much in the minds of the Lord President and his advisory councils in order to be sure that Britain's effort in these fields is adequate, wisely directed and so concerted as to avoid duplication and waste of effort or resources.

SOCIAL CONDITIONS AND THE DEVELOPMENT OF SCIENCE

Essays on the Social History of Science
Edited by S. Lilley. (Centaurus, Vol. 3, 1953, Number 1–2.) Pp. 182. (Copenhagen: Ejnar Munksgaard, 1953.) 30 kroner.

THIS book contains twelve essays in English by eleven authors on various features of the history of science from the earliest times to the present, with special reference to their social aspects. There is also a brief introduction purporting to describe the origin and character of the volume. There is much in the book of great interest and value which it would be wrong not to mention. In a brief review, however, attention must be focused on the predominant tone, and, despite its intermittent utterance and the merits of intervening accents, of this there is no doubt. It is clearly sounded by the writer of the introduction: "the fundamental trend of social evolution and the position of science in it . . . is the development of the means of economic production which primarily determines the development of all other human activities, not excluding intellectual and spiritual development. I regret that so many prominent scholars are too timid to accept this general inference as a guidance in their studies" (p. 11).

It may, of course, be sagacity rather than timidity that accounts for this lamentable failure, but, however that may be, the editor's team includes a goodly company of brave men prepared to follow the trumpet-call wherever it leads them. Unfortunately, their logic and perspicacity are not always equal to their courage. Two qualities of the book specially strike the unconditioned reader: first, a tacit change of meaning of a phrase before its use in an argument; second, blindness to the major elements of a process and exaltation into pre-eminence of minor details.

On p. 12, for example, we are invited to accept a definition of science as "in effect, a traditional body of observations, expressed in mutually intelligible symbols . . . and providing rules for concerted action on a common environment—in other words a sort of ideal map or conceptual working model of reality serving as a guide to action". Few would quarrel with this, whether or not it could be improved upon. But two pages later we read: "Social relations are thus inevitably common knowledge, and only common knowledge is a serviceable guide to concerted action". "Common environment" has now become "common knowledge". The man who goes voyaging through strange seas of thought alone is no longer a scientist, and can be made to toe the line. Moreover, common knowledge is identified with social relations, and the way is clear to claim science as essentially a social matter and therefore properly subject to control by the State. The writer does not here take this final step, but he makes it almost irresistible, and others have taken it.

Another example is found in the discussion (p. 59) as to whether a new scientific development is called forth by the internal state of science or by social needs. The writer claims that both are necessary, but the only evidence given for the latter is the obvious fact that, if the social organization regards the development as dangerous and removes the opportunities for making it, then it will not occur. Because social needs can hinder progress, they must be necessary to produce it. On the same grounds, prussic acid can be proved necessary to life.

Oversight of the obvious with magnification of the trivial is illustrated by the statement (p. 61) that the "essential factor" in the discovery of the conservation of energy was "the importation into science of habits of thought that were created by the social agency of the Industrial Revolution". It seems not to have occurred to the writer that the conservation of energy was discovered first of all because energy is conserved, and men intent on finding out what remains constant amid changes must inevitably discover it. The utmost that extraneous influences can do (provided they do not prevent scientific research entirely) is slightly to affect the time of discovery and perhaps the terms in which it is expressed. After reading the account given here, an uncritical reader would probably conclude that under other social conditions it would have been discovered that energy was not conserved.

Similar perversity is seen in the lengthy discussion (pp. 65–9) of the reasons why Galileo and not Leonardo laid the foundations of modern science. The writer sees only two possible explanations, "one in terms of the internal development of scholastic science, the other in terms of social changes". Again, it does not occur to him that at least 99·9 per cent of the reason was that Leonardo was Leonardo and Galileo was Galileo, and that if their dates had been interchanged Galileo would not have painted the

Mona Lisa and Leonardo would not have translated the book of Nature into the mathematical language. The fact that none of their countless contemporaries, though exposed to exactly the same states of scholastic science and social changes, produced anything approaching their achievements would have made this obvious to anyone not bemused by a theory already impregnably fortified against the onslaught of facts of any kind.

The influence of scientific knowledge on social history has been badly overlooked in the past, but the fault is not rectified by exaggerating into a major cause the slight effect of social changes on the direction of advance of scientific knowledge. The path from this error of State control of science is fatally easy. If I were not too timid I would express myself strongly on this matter.

HERBERT DINGLE

ARCHÆOLOGY OF LACHISH IN THE NEAR EAST

The Wellcome–Marston Archæological Research Expedition to the Near East

Lachish 3 (Tell ed-Duweir): The Iron Age. By Olga Tufnell. With contributions by Margaret A. Murray and David Diringer. Text, Pp. 438. Plates, Pp. 10 + 130. 2 Vols. (London, New York and Toronto: Oxford University Press, 1953.) £8 8*s*. net.

IT is now generally accepted that Tell ed-Duweir marks the site of the ancient city of Lachish, which was frequently mentioned in the Old Testament and twice in the ancient Assyrian records. The present volume, well printed and illustrated with excellent photographs, describes the successive foundations of the city and the changes which occurred from approximately 1180 B.C. to the middle of the fourth century. During that long period there seem to have been at least five major rebuildings, of which architecturally the most interesting are those between periods 3 and 1.

There is some doubt as to who may have been responsible for the heavy burning of the city in the twelfth century B.C., though inevitably that event must in some way be correlated with the Peoples of the Sea; but whether or not the destruction was due to a punitive attack by the Egyptians cannot be decisively proved.

In levels 4 and 3 the contents of the tombs as well as what was discovered in the city show that the place was in close contact with Egypt, and the archæological evidence would suggest that the phase of economic decline which occurred towards the end of this period may well have been due to the fact that it was cut off by increasing pressure of Assyria on North Syria from any northern trade.

In the next phase, which covers the eighth century B.C., there occurs a wheel-burnished pottery of very good quality, a type which had come into general use in the city of Samaria in about 800 B.C. and is a means of providing a valuable synchronization. To this level, too, belongs a series of early Hebrew characters on royal stamps, and these form part of the dating evidence used as a basis for the chronology by Dr. David Diringer.

The end of period 3 is clearly defined by a violent burning and destruction. The evidence supports the author's conclusions that this event is most probably to be ascribed to the conquest by Sennacherib of the city in 700 B.C., an event recorded not only in the Old Testament and the Assyrian records, but also actually illustrated on a bas-relief discovered by Layard at Nineveh. It is therefore significant that the architecture of this phase was obviously related to a contemporary style in Assyria. The most important of the monuments is a well-dressed limestone podium surmounted by mud-brick, which is characteristic also of the Sargonid occupations at Khorsabad and Nimrud. It appears, however, that this architectural style, so strikingly illustrated in Assyria during the eighth century B.C., has a longer history behind it in Palestine, and this discovery at Lachish therefore raises an attractive problem.

No less interesting architecturally is a stone building in the latest level 1, which has been appropriately named the residency of the Persian governor. This is rightly thought not to be Achæmenian in style, but to reflect a Syro–Hittite origin. Here, however, we may perhaps also look to Assyria and find a parallel in a spacious residency of the sixth century B.C. discovered by Andræ at Assur.

This volume contains a great variety of significant material which has been well set out for study by scholars, and in itself provides a mine of important information. A debt is owed to the many authorities who have contributed to this work, but most of all to the devoted labours of Miss Olga Tufnell, who has in exemplary fashion set out the results of this expedition and overcome the very great difficulties which must beset anyone who attempts publication when the leader no longer survives to complete his task. The Wellcome–Marston Trustees are to be congratulated on this admirable achievement.

M. E. L. MALLOWAN

STUDY OF MANAGEMENT

The Principles and Practice of Management

Edited by E. F. L. Brech. Associate authors: R. M. Aldrich, A. W. Field, J. Maddock, and Frank L. Woodroffe. Pp. xvi+752. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 50*s*. net.

SCIENCE or art: academic or practical: graduate or man from the shop floor? These are among the questions which are being hotly discussed in industry to-day; the answers may well decide the future of industrial endeavour in Britain and, inseparably, the whole pattern of the British way of life.

For these and other reasons "The Principles and Practice of Management" is an important book. In it the editor and his associate authors unflinchingly declare their faith that, while management at all levels must be learned by practice, there is also a considerable body of knowledge which can be studied and which no competent manager of to-morrow can afford to ignore. They have been jointly concerned to present some of this knowledge and, for the attempt alone, are to be warmly commended.

The book is divided into six parts. The first presents the analytical framework within which the whole process of management is reviewed and the underlying principles examined. The last is concerned with management in practice and deals with such topics as the functional principle, the use of committees in organization and the place of management in national affairs; both parts have been

contributed by the editor. Between the general principles and practice of management come sections dealing with what are described as the major divisions of management: distribution, production, personnel and control. Each of these has been contributed by a specialist with considerable practical experience in his own field.

Under distribution, the author includes all direct and incidental sales activities, advertising, public relations, warehousing, stock control and transport. The author of the section on production describes such activities as design, production methods, work measurement, production planning, production control, supervision, buying, store-keeping, works maintenance and inspection. The personnel function of management is described as the nervous system of the organization and includes such topics as industrial relations, training and promotion and withdrawals, physical working conditions, employee services and the mechanics of arbitration. Control is mainly concerned with the financial aspects of management and deals with such processes as the preparation and use of budgets, the application of budgetary control, cost control and clerical management.

In a book with such a wide range of authorship, it is not surprising to find over-lapping and variation in principle and details between author and author; the editor has, in fact, made no attempt to circumscribe the authors so that they would write to an agreed body of principles. What is surprising is that so much of the over-lap consists of tedious repetition and that much of the text is loose, contradictory and, too often, inaccurate.

More serious is the claim that this book should be regarded as the reference book for those wishing to practise 'scientific management'. The whole book is unquestionably founded upon good practical experience; this does not preclude the possibility that other students of management with equally good practical experience might present their ideas on management in a different way. It is questionable, too, whether this essay in empiricism might not have served a better purpose if it had appeared, not as a declared reference book, but as a series of much shorter volumes dealing with particular aspects of the management function; each of the volumes could then be superseded as new knowledge and experience are gained in a branch of study which its most ardent exponents still believe to be in the very early stages of growth.

T. H. Hawkins

INFORMATION THEORY MADE EASY

Probability and Information Theory, with Applications to Radar

By P. M. Woodward. (Pergamon Science Series: Electronics and Waves—a Series of Monographs.) Pp. x+128. (London: Pergamon Press, Ltd.; New York: McGraw-Hill Book Co., Inc., 1953.) 21*s*.

EVEN an author with Mr. Woodward's ability of explaining complicated matters in simple and attractive language is rather too severely handicapped if he has to explain information theory on 125 small pages, leading up to three specialized chapters on radar, and if on the way he has to explain all the mathematics required, from probability to Fourier integrals. In this process of condensation and popularization a few things must go by the board. Mathematical rigour is the first victim, and the least regretted. A more serious loss is, in the present case, that this little book may not be a very suitable introduction to the more recondite works on communication theory. Mr. Woodward has followed an 'easy way' of his own invention, which is smooth enough as far as it goes, but is likely to become an impasse later on.

Statistical communication theory centres on Claude Shannon's fundamental theorem: there exists a maximum amount of *certain* information which can be transmitted per symbol *on the average* from an ergodic source through a noisy channel. This maximum can be approached to any limit by suitable coding methods, which deal with the messages in large lumps of symbols. The theorem says nothing about individual messages; evidently a single, short message can convey no certainties whatever.

If $p(x)$ is the probability of a symbol x being sent, if $p(x,y)$ is the joint probability of x being sent and y received, and if $p_y(x)=p(x,y)/p(y)$ is the conditional probability of x having been sent when y is received, the upper limit is

$$H(x)-H_y(x)=-\sum_x p(x)\log_2 p(x)+\sum_x\sum_y p(x,y)\log_2 p_y(x)$$

measured in 'bits' per symbol, that is to say in terms of binary decisions. It is worth while stating this theorem in some detail, because it comprises implicitly perhaps 90 per cent of present-day statistical communication theory—among others the results of Woodward and Davies on radar information. There is, of course, the danger that one may be inclined to forget one or the other of the unfamiliar qualifications in such a long statement.

Mr. Woodward's 'easy way' panders to this human weakness by giving a *detailed* interpretation to the terms which occur in the theorem, and suppressing, at least temporarily, the all-important stipulation 'on the average'. In his view, if a symbol x is received whose *a priori* probability was $p(x)$, there is a transfer of information of the amount $\log_2 p(x)$ bits. If the transmission is marred by noise, one must deduct from this the logarithm of the *a posteriori* probability of x being meant, which is less than certainty. This is a detailed interpretation, quite similar in nature to Ampère's law of the interaction of two 'current elements', or to Poynting's picture of the energy flow, which is a detailed interpretation of the energy integral in Maxwell's theory. The danger of these detailed pictures is that one forgets that they operate with undefined and undefinable quantities. 'Current elements' do not exist, the energy flow density cannot be measured, and information transfer is an empty word until one averages it over long messages. Yet, the didactical and stimulating value of this sort of approach cannot be denied. After all, even Maxwell's field theory is an over-detailed picture, whose purpose is to account for the energy and momentum exchanges between charged particles, which alone are measurable. One must forgive Mr. Woodward all his verbal operations for a stimulating sentence such as "the ideal receiver must directly display the *a posteriori* probabilities".

By and large, this little book admirably fulfils its purpose of making a tasty dish for the moderately mathematically minded engineer out of the driest and most indigestible fare, and giving him a little intuitive understanding in preference to a full-blown inferiority complex.

D. Gabor

THE BRITISH FUNDAMENTAL GRAVITY STATION

NEW SITE AT THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON, MIDDLESEX

THE British National Gravity Base was for many years situated at Greenwich Observatory. Originally a site in the Record Room was chosen, but, in 1927, a new position was selected some 300 metres east of the Observatory in the old Magnetic Pavilion. This building has now been demolished, and in view of the fact that the Royal Observatory is being transferred from Greenwich to Herstmonceux a new site had to be found. Meanwhile, in accordance with a resolution made by the International Gravimetric Commission at its meeting in Paris in September 1953, the British National Gravity Base was named the British Fundamental Gravity Station.

At the Ninth General Assembly of the International Union for Geodesy and Geophysics held in Brussels in 1951, a resolution was passed by the International Association for Geodesy urging "each country to ensure that their primary station is established in a suitable permanent position".

At its meeting on June 30, 1952, the British National Committee for Geodesy and Geophysics resolved that the British Fundamental Gravity Station should be at the National Physical Laboratory, Teddington, Middlesex, on the site of Clark's (1939) absolute determination of gravity in Room No. 11 of the Metrology Division building. The geodetic co-ordinates (see Figs. 1 and 2) and height of the pillar which Clark used are:

Latitude	51° 25′ 13·6″ N.
Longitude	0° 20′ 21·4″ W.
Height (Newlyn datum)	9·23 m.

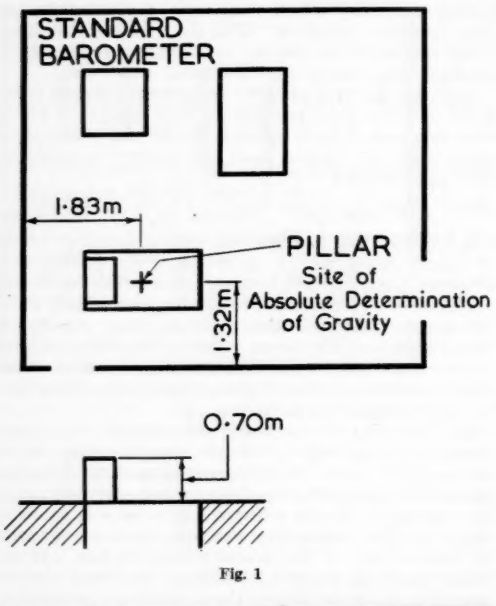


Fig. 1

The pillar, which is situated in the south-east corner of the room, has most of its upper surface at floor-level. There is an extension of height 70 cm. at one end; but this is a later addition and has no connexion with Clark's experiments. Most of the relative measurements of gravity at this site have been made with apparatus standing on the floor, and it is recommended that this practice should be continued. The mean height of the centre of gravity of Clark's pendulum was 95 cm. above floor-level. It was therefore subjected to a mean acceleration of gravity 0·29 mgal. less than at floor-level. The pillar is set 6 ft. into the subsoil and under normal conditions is very steady; but occasionally some disturbance due to nearby building work and heavy machinery has been noticed (Clark, 1939, Cook, 1952).

If circumstances arise which make it inconvenient to observe on Clark's pillar, there are two subsidiary sites nearby which are well compared with the Fundamental Gravity Station:

(1) On the roadway immediately outside the west door of the main east–west corridor of the Metrology Building (Fig. 2) approximately 30 m. west of the Fundamental Gravity Station. The geodetic co-ordinates are:

Latitude	51° 25′ 14″ N.
Longitude	0° 20′ 23″ W.
Height (Newlyn datum)	9·24 m.

The value of gravity at this site is known to be the same as at the National Base within ± 0·02 mgal.

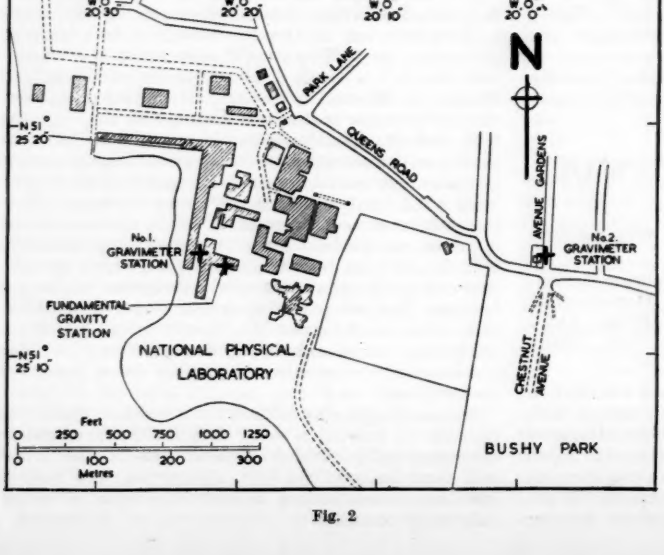


Fig. 2

(2) On the west side of the road in Avenue Gardens, Teddington, about 20 m. from the junction with Park Road (Fig. 2). The geodetic co-ordinates are:

Latitude	51° 25′ 14″ N.
Longitude	0° 19′ 55″ W.
Height (Newlyn datum)	9·60 m.

The value of gravity at this site is 0·04 ± 0·02 mgal. greater than at the National Base.

BIBLIOGRAPHY

Absolute Measurement

Clark, J. S., "An Absolute Determination of the Acceleration due to Gravity", *Phil. Trans. Roy. Soc.*, A, **238**, 65 (1939).

Jeffreys, H., "On the Absolute Measurement of Gravity", *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 398 (1949).

Comparisons with Other Countries

Browne, B. C., and Bullard, E. C., "Comparison of the Acceleration due to Gravity at the National Laboratory, Teddington, and the Bureau of Standards, Washington, D.C.", *Proc. Roy. Soc.*, A, 175, 110 (1940).

Cook, A. H., "Comparison of the Acceleration due to Gravity at the National Physical Laboratory, Teddington, the Bureau International des Poids et Mesures, Sèvres, the Physikalisch-Technische Bundesanstalt, Brunswick, and the Geodetic Institute, Potsdam", *Proc. Roy. Soc.*, A, **213**, 408 (1952).

Jelstrup, G., and Trovaag, O., "Gravity Comparisons, Oslo–Teddington–Stockholm–Copenhagen" (Oslo, Den Norske Gradmålingskommisjon, 1950).

Martin, J., *C.R. Acad. Sci., Paris*, **228**, 658 (1949).

Martin, J., and Duclaux, F., "Résultats de la première campagne gravimetrique effectuée en Afrique" (Paris: Office de la Recherche Scientifique Outre-Mer, 1952).

Morelli, C., "Taratura di due Gravimetri Worden e Collegamenti europei", *Ann. Geofis.*, **4**, No. 4, 493 (1951).

Woollard, G. P., "The Gravity Meter as a Geodetic Instrument", *Geophysics*, **15**, 1 (1950).

Woollard, G. P., *et al.*, "World Wide Gravity Measurements conducted during the Period June, 1949–January, 1952". Report to the Office of Naval Research, Contract *N* 6042–27704, U.S.A., Woods Hole, Massachusetts.

Comparisons with British Stations

Bullard, E. C., and Jolly, H. L. P., "Gravity Measurements in Great Britain", *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **3**, 443 (1936).

Bullerwell, W., "Gravimeter Observations comparing Pendulum Stations at Cambridge, York, Newcastle-upon-Tyne, Edinburgh and Aberdeen", *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, No. 5, 303 (1952).

Cook, A. H., "A Measurement of the Difference of Gravity between the National Physical Laboratory, Teddington, and the Ordnance Survey Office, Southampton, *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, No. 5, 319 (1952).

Cook, A. H., "Adjustment of the Principal Gravity Observations in Great Britain", *Mon. Not. Roy. Astro. Soc. Geophys. Supp.*, **6**, No. 8, 494 (1953).

PITHECANTHROPUS, MEGANTHROPUS AND THE AUSTRALOPITHECINAE*

By Prof. G. H. R. von KOENIGSWALD

University of Utrecht

A VERY important group of higher Primates has been discovered in Africa, the Australopithecinae[1]. They include *Australopithecus*, *Plesianthropus* and *Paranthropus* from South and most probably "*Meganthropus africanus*"[2] from East Africa. The position of *Telanthropus* from the *Plesianthropus*-layers of Swartkrans is still under dispute.

The large amount of material now at hand leaves no doubt that the Australopithecinae are members of the Hominidae. With this group they share the upright gait, which can be concluded from the pelvis, used by *Plesianthropus* and *Paranthropus*, and several important peculiarities of the skull and the dentition. The *Australopithecus* from Makapansgat owes the name "*prometheus*" to Dart's suggestion that he knew the use of fire, which, however, was disputed by Broom[3]. Dart has also suggested that certain battered ungulate humeri from the same site are evidence of a "predatory implemental technique"[4]; however, exactly the same type of damage is caused by hyænas[5], which are also known from Makapansgat[6].

* Summary of a lecture given at University College, London, on March 12.

The oldest known, undoubtedly human beings, are the *Pithecanthropi* of Asia, including *Pithecanthropus*, *Sinanthropus* and *Meganthropus*. Do the Australopithecinae represent an ancestral type? Are they really older and more primitive?

First of all, the known Australopithecinae are, geologically, not older than *Meganthropus* and *Pithecanthropus modjokertensis* (not *Pithecanthropus robustus*) from the Lower Pleistocene of Java[7]. In at least two of the South African sites, Kromdraai and Swartkrans, the horse, *Equus*, is found, which is the best guide fossil for the Pleistocene, and at Sterkfontein and Swartkrans we find an extinct carnivore, *Lycyaena*, which even in Europe existed until the Villafranchian[8]. There is no definite proof that any of the other sites is really of Pliocene age.

The best-known hominid from the Lower Pleistocene of Java is *Pithecanthropus modjokertensis*. This form has retained the 'simian gap', which is a very primitive characteristic which might be expected in an early human forerunner; for Remane, in a very careful study, has shown that even in the dentition of modern man there are peculiarities due to his forerunners having much better developed canines[9]. This gap has already disappeared in the full-grown Australopithecinae—although it seems to be present in the deciduous dentition of *Australopithecus africanus*; but while this *Pithecanthropus* in spite of the primitive dentition possesses a typical human entrance to the nose with a well-developed nasal septum, in the Australopithecinae—I quote from a description of *Paranthropus crassidens*—"except that the inner parts of the premaxillaries pass considerably further back, the resemblance of this region to that of the chimpanzee is considerable"[10].

The incisors in *Pithecanthropus* are well developed. In the Australopithecinae they are much reduced, in some cases even below the minimum values known for modern man. Minimum values for central incisors are, for *Paranthropus crassidens* and *Homo sapiens*, upper 7·5 and 8·0 mm., lower 5·0 and 4·6 mm., respectively. The relative values are much higher, as the average length for the first lower molar in *crassidens* is 15·0 mm., in modern man 11·1 mm. The canines are of about the same size in both groups.

In modern man the first lower premolar is only a little smaller than the second (in some Eskimos we still find the reverse), the average being 0·3 mm. But it is 1·3 mm. in *Paranthropus crassidens*. In *Sinanthropus* the first premolar is largest, also in *Meganthropus*, and generally in all anthropoids. This surely is the primitive condition. As a whole, in the Australopithecinae the incisor–canine–premolar group is more reduced not only as in *Pithecanthropus* but also more than in modern man. In connexion with this reduction, the dental arcade shows a typical shortening, which has been demonstrated by Le Gros Clark[11].

In spite of all these specializations, the roots of the premolars in *Paranthropus* do not differ in number from those observed generally in the anthropoids. In the lower jaw the second premolar has two roots, and in the upper jaw the first and the second both have three. In *Pithecanthropus* the lower premolar in question is single-rooted, the first upper has three and the second two roots. In modern man two roots in the second lower premolar are extremely rare (one case was observed among 2,089 specimens), while three separate roots occur in the first upper premolar in 3 per cent, three roots in the second in only 0·3 per cent, two in 3·5 per cent of specimens[12].

In the relative size of the molars, the increase in size from the first to the last lower molar, and in the upper jaw the second molar being larger than the first, *Pithecanthropus* shows the same primitive conditions as the Australopithecinae and the anthropoids. There is, however, a tendency for the last upper molar in *Paranthropus crassidens* to be enlarged; this is not found either in the Hominidae (in modern man this molar is often completely reduced) or in the anthropoids.

The deciduous dentition is of great value for the determination of the phylogenetic position. In *Sinanthropus* as in *Pithecanthropus modjokertensis* the first lower deciduous molar has two main cusps—as also the chimpanzee and the orang; in the first form the entoconid is absent, as is common in the anthropoids, in the second very faint. Complete absence of the entoconid in modern man is found in about 2 per cent of specimens only. In the Australopithecinae this cusp is not only developed to the same degree as in modern man (in *Australopithecus africanus* this point is not so clear), but there is also a tendency towards a complete molarization of this tooth, which reaches a maximum in *Plesianthropus transvaalensis* for the upper and in *Paranthropus robustus* for the lower molar; in the latter form, except for its size, this tooth is indistinguishable from the second deciduous molar. There is a certain amount of variability in modern man; but extreme conditions like these have not been observed in a vast collection of modern teeth at our disposal (Bolk Collection, Amsterdam).

This comparison already reveals so many features which must be regarded as a sign of over-specialization that they exclude the Australopithecinae from the ancestorship not only of *Pithecanthropus* but also of *Homo sapiens*.

A greater resemblance exists between the Australopithecinae and the imperfectly known *Meganthropus* from Java; so much so that recently Robinson has included the Javanese species in the same group[2]. He shows that, especially in the formation of the symphysis, there is a very great resemblance, and he mentions the occurrence of a mental spine in a certain specimen of *Paranthropus crassidens*. We are looking forward with great interest to his final publication.

There are, however, some differences, in which *Meganthropus* is more primitive. There is the basic pattern of the premolars and the first molar, which still have an undivided ridge between protoconid and metaconid, conditions which I could not detect in any of the South African species. The same is true of the presence of a paraconid on the second lower deciduous molar. The first lower premolar is of a more oval outline in the Australopithecinae, whereas in *Meganthropus* it is more angular, as in *Sinanthropus* and Heidelberg man.

The dental arch is probably very similar in both forms, as is evident from a new find, discovered last year[12]. This specimen, however, is crushed, and therefore not reliable.

There is not a single feature in the original *Meganthropus* jaw fragment which cannot be matched with other primitive human jaws. In the corresponding part of the *Australopithecus* mandible the two-rooted second premolar must already be regarded as a sign that it belongs to a different category. In fossil human jaws this condition has never been observed; in modern man it occurs in less than 0·02 per cent of specimens. When more is known of *Meganthropus*, it will probably be found that there are more differences of significance.

However, there can be no doubt that *Meganthropus* and the Australopithecinae have a common ancestor. Such a form must have still had the 'simian gap'—*vide Pithecanthropus*—relatively large canines and incisors, large first lower premolars, and a primitive deciduous dentition. Therefore, it will not fall into the group of the Australopithecinae *s. str.*, and for that reason I cannot agree with Robinson, who claims that the Australopithecinae are "ancestral to the euhominid group" (see ref. 2, p. 37).

Table 1. Mesiodistal Length of the three Lower Molars

Lower Pleistocene:	*Meganthropus*	44·0 mm.
	Pithecanthropus modjokertensis	39·5 mm.
Middle Pleistocene:	*Sinanthropus pekinensis* (G)	37·7 mm.
	Homo heidelbergensis	36·5 mm.
Upper Pleistocene:	*Homo neanderthalensis* (Spy II)	34·0 mm.
Recent:	*Homo sapiens* (White, average)	32·5 mm.

Within this latter group there is a very strong tendency towards a reduction of the dentition, and parallel with it an exaggerated increase in brain capacity (Table 1). The same mesiodistal lengths are for *Plesianthropus transvaalensis* 44·0 mm., and for *Paranthropus crassidens* (average) no less than 48·4 mm., respectively.

Also in regard to the brain capacity the conditions seem fundamentally different. The capacity of the Australopithecinae is a controversial question; Broom gives estimates up to more than 1,000 c.c.[14], and Schepers even calculates "cephalization coefficients" (see Schepers, ref. 14). Let us not forget that only a single skull can be measured, *Plesianthropus* V, and that here the capacity is only 482 c.c.

Most probably in their absolute brain capacity the Australopithecinae bridge the gap which exists between the largest brain of the anthropoids (gorilla with 585 c.c.) and the smallest of the Hominidae (*Pithecanthropus erectus* II with 775 c.c.). There is, however, this important difference: the greatest brain capacity in the Australopithecinae goes together with the largest molars, whereas in man it goes with the smallest molars. We have tried to express this relation in a brain–molar coefficient[15]—brain capacity in cubic centimetres divided by the mesiodistal length of the three upper molars in millimetres, both measurements taken on the same skull—the results of which are given in Table 2.

Table 2. Brain–Molar Coefficients

(The numbers in brackets indicate the number of skulls measured)

Chimpanzee (7)	10·9–13·9	average:	11·8
Orang (16)	9·8–12·4		10·9
Gorilla (10)	9·0–13·0		11·7
Plesianthropus V	13·4		
Pithecanthropus modjokertensis	25·8		
Pithecanthropus erectus	24·3		
Sinanthropus pekinensis XI	34·2		
Homo neanderthalensis (Steinheim)	36·7		
Homo sapiens (Europeans, 10)	33·5–57·1		47·3

As we expected, the modern anthropoids form a homogeneous group. The values for *Pithecanthropus* are estimates: a capacity of 1,000 c.c. was estimated by Weidenreich for the skull of *modjokertensis*, and for *erectus* we have used a dentition, not yet described, from a different individual. In Table 2 the anthropoids are sharply separated from the Hominidae; *Plesianthropus* is not intermediate, since it comes within the range of the anthropoids.

This coefficient has still another advantage. If we take a maximum of about 15 for the anthropoids, then the Australopithecinae with their large molars will still remain within the anthropoid group, even with a brain capacity of more than 700 c.c.

Two specimens of the large *Plesianthropus* from Swartkrans have a well-developed sagittal crest[15], which is not found in the smaller species. Apart from the fact that this must be taken as a sign of a limited brain capacity, it is to be noted that a sagittal crest in the anthropoids depends upon the absolute size of the species. It is absent from the small gibbon, very rare in male chimpanzees, normal in male orangs and practically always present in the male and often in the large female gorillas. That this structure appears among the Australopithecinae under the same conditions is a very important parallel to the anthropoids, and a significant difference from the Hominidae.

Thus the Australopithecinae apparently are a group of the Hominidæ, which most probably did not rise much above the 'anthropoid' level. The reduction of the dentition only affects the face; their increase in brain capacity is slight and depends upon the absolute size of the species; the possession of a sagittal crest in the large specimen parallels the development of the same structure in the anthropoids. It seems that towards the end of the Pliocene period the early Hominidae were separated into several branches—Australopithecinae in Africa, *Gigantopithecus* (and undescribed forms) in China, Pithecanthropi in Asia—and that only one of them, the Pithecanthropi, by a harmonious reduction of the whole dentition and—this is the most important point—by an exaggerated and accelerated increase of the brain capacity, gave rise to the Hominidae, of which group we are the most human members.

[1] Gregory, W. K., and Hellman, M., *Ann. Transvaal Mus.*, **19**, 339 (1939).
[2] Robinson, J. T., *Amer. J. Phys. Anthrop.*, **11**, 1 (1953).
[3] Broom, R., "Finding the Missing Link", 74 (London, 1950).
[4] Dart, R. A., *Amer. J. Phys. Anthrop.*, **7**, 1 (1949).
[5] Zapfe, H., *Palaeobiologica*, **7**, 111 (1939).
[6] Toerien, M. J., *S. Afric. J. Sci.*, **48**, 293 (1952).
[7] von Koenigswald, G. H. R., Rep. Int. Geol. Congr. Great Britain 1948, part IX, 59 (1950).
[8] del Campana, D., *Palaeontologia Italica*, **19**, 189 (1913).
[9] Remane, A., *Z. f. Anat. u. Entwicklungsgesch.*, **88**, 391 (1927).
[10] Broom, R., and Robinson, J. T., *Transvaal Mus. Mem.*, **6**, 1 (1952).
[11] Clark, W. E. Le Gros, *J. Roy. Anthrop. Inst.*, **80**, 37 (1952).
[12] Visser, J. B., Diss. Zurich, 1 (1948).
[13] Marks, P., *Madjalah Ilum Alam Untuk Indonesia*, **109**, 26 (1953).
[14] Broom, R., Robinson, J. T., and Schepers, *Transvaal Mus. Mem.*, **4**, 1 (1950).
[15] von Koenigswald, G. H. R., *Proc. Kon. Ned. Akad. Wetensch.*, B, **56**, 403 and 427 (1953); **57**, 85 (1954).

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR THE YEAR 1952–53

THE report of the Department of Scientific and Industrial Research for the year 1952–53* follows the accepted pattern of previous years. Now exceeding three hundred pages, it includes the short report of the Committee of the Privy Council, over Lord Salisbury's signature, and the thirty-eighth annual report of the Advisory Council, signed by Sir Ian Heilbron, together with the usual summary of work carried out by the various research stations and boards and research associations. The appendixes include a thirty-seven page classified list of departmental publications issued during the year and the usual lists of assessors to the Advisory Council, of members of the research boards of the Department, and of grants for special investigations during the year. With the lists of the Department's establishments and of the research associations, it provides the scientific and industrial world with material for a sound judgment as to the worth of the Department's work, though the average member of Parliament may well be glad of some further guidance from the Parliamentary and Scientific Committee in assessing the value which the nation is getting for an expenditure of £5,773,303 gross during the year ended March 31, 1953.

This figure compares with £5,452,165 in the previous year and was reduced to £5,207,455 by various receipts (mainly by the National Physical Laboratory) for work done for other Government departments or for industry, the net increase on 1951–52 being £250,636. On October 1, 1953, the Department employed 4,073 staff of all grades (including 159 part-time), compared with 4,035 (149 part-time) the previous year. Annual grants to research associations, totalling £1,449,635, with special grants of £16,804, were as usual the largest single item of expenditure, followed by that of £860,842 gross, or £546,617 net, on the National Physical Laboratory. Grants for special researches remained at about the same level, £317,321, compared with £313,693 during 1951–52. Most of those listed are spread over a period of years, the largest, apart from the £230,000 for radio-astronomy at the University of Manchester, being £617,500 for the construction of a 400-MeV. proton synchro-cyclotron and other high-energy equipment for nuclear physics research at the University of Liverpool, £354,700 for the construction of a 300-MeV. electron synchroton and other high-energy equipment for nuclear physics research at the University of Glasgow, £231,500 for the construction of a 1,000-MeV. proton synchrotron and experimental work with a 60-in. cyclotron at the University of Birmingham, £191,000 for the construction of a 140-MeV. electron synchrotron and other equipment for nuclear physics research at the University of Oxford, and £160,000 for construction of a 300–400 MeV. linear electron accelerator at the University of Cambridge. Besides this, grants amounting to as much as £209,500 (University of Liverpool) have been made for running expenditure on nuclear physics research. These grants for running expenditure, which total more than £800,000, extend for five years from August 1, 1952; and by the end of that period the Advisory Council expects these heavy financial responsibilities for nuclear research in the universities to be terminated so as to bring its net annual resources for general purposes to something of the order of six million pounds.

Grants to students amounted to £265,897 net, an increase of £14,656, the number of students in training being 976, compared with 923 during 1951–52, and 413 of these were new. Senior research awards numbered fourteen, seven of which were new, compared with thirteen during 1951–52, and forty-one new grants for special investigations brought the total of such grants to seventy, compared with ninety-one during 1951–52. Of the senior research awards, eight were in physics and three each in chemistry and in engineering; and of the grants for special investigations, thirty-two were in physics, twenty in chemistry, and six each in biology and in engineering. Chemistry claimed 419 and physics 283 of the grants to students; 79 were in engineering,

* Department of Scientific and Industrial Research. Report for the Year 1952–53 (Cmd. 9083). Pp. 315. (London: H.M.S.O., 1954.) 8s. net.

78 in biology, 50 in mathematics and astronomy, 41 in geology and mineralogy, and 26 in metallurgy.

With the exception of building research, expenditure on which decreased by £77,190 to £420,933 net, and on the National Physical Laboratory, which showed a net decrease of £12,718, expenditure on all sections of the work increased, although net expenditure on water pollution research (£61,424), fire research (£26,344), hydraulics (£57,676), pest infestation (£56,636), forest products research (£106,114) and on the Geological Survey and Museum (£206,131) was no more than up to 10 per cent higher than during 1951–52. The larger increases of £17,051 on the Chemical Research Laboratory (to £113,574 net), of £18,538 on fuel research (to £237,692) and of £19,506 on road research (to £292,965) fell well within the same order of magnitude. Only the increases of £27,703 on radio research (to £50,719), of £34,502 on food investigation (to £220,531) and of £78,733 on mechanical engineering, represent more significant increases in the scale of operations.

At a total of £346,157, net expenditure on mechanical engineering ranks fourth in the net outgoings of the Department, and it is now expected that the essential building programme will be completed by 1959 at a cost of about £2 million. More than £500,000 has now been expended on the purchase of the site and on buildings at East Kilbride for the Mechanical Engineering Research Organization, and a staff of more than 250 was built up towards the total of 500–700 contemplated in the original proposals for the Organization. The Advisory Council comments on the much more favourable prospects for the expansion of this Organization during the five years commencing April 1, 1954, under the new arrangements announced in November last, particularly in view of the greater flexibility given by the provision that surplus funds due to underspending in any one year may be carried over to subsequent years. Apart from this, provision has been made for small increases of staff and of expenditure on new buildings during the current financial year both at East Kilbride and for the Hydraulics Research Station at Wallingford. At the latter station some three-quarters of the staff originally contemplated have now been recruited, largely within the past year, and by early 1955 some £500,000 will have been expended on the purchase of the site and provision of buildings. A good beginning has already been made with a substantial programme of research, including experimental studies with models of river estuaries and harbours, theoretical studies of the movement of materials by the action of waves, coast erosion, and the development of instruments. In a study of the changes in the bed of Morecambe Bay, made at the request of the Railway Executive and completed during the year, the Station was able to show that the changes occur cyclically and that the present deterioration of the channel to Heysham Harbour would not be permanent. Progress has also been made in developing research techniques for the study of coastal erosion; a pneumatic tide-generator for use in models has been developed, and the Advisory Council was satisfied on its visit to the Station that important contributions to this branch of civil engineering are already being made there.

The two other establishments of the Department which were formally visited by the Advisory Council during the year were the National Physical Laboratory and the Chemical Research Laboratory, both of which are at Teddington. The former is by far the largest of the establishments and is also the most diverse in its activities, although work is continually being transferred from the Laboratory to form the basis of new institutions. The Advisory Council, emphasizing the dynamic character of the National Physical Laboratory's organization, points out that much of its work is undertaken to serve the basic needs of industry in general and of the public. Its work on the maintenance of increasingly accurate standards of measurement, although only a small part of the Laboratory's work, remains of fundamental importance, and measurements of the speed of light or the development of a new method of producing diffraction gratings are no longer of purely academic interest but of fundamental importance in both science and industry. Theoretical studies and small-scale experiments in wind tunnels by the Aerodynamics Division of the Laboratory are assisting to define the nature of the problems of the behaviour of bodies moving in air at speeds greater than that of sound, which confront the designer of aircraft; and in the theoretical studies of high-speed flight, and in a wide range of other investigations, the Automatic Computing Engine, designed and built at the Laboratory with the help of industry, is assisting to solve mathematical problems of great complexity.

The Advisory Council's visit equally convinced it of the importance of the work of the Chemical Research Laboratory. It was particularly impressed by the work of the new radiochemical laboratory on the analysis and concentration of radioactive materials, and the importance of microbiological work of the Laboratory is also stressed in the report. The work of this Laboratory has recently been reviewed in these columns (*Nature*, **172**, 664 and 832; 1953), and no more need here be added than that the Advisory Council directs attention to the economic value of the work on the corrosion of metals and the recovery of valuable constituents from waste materials or low-grade sources.

From the account of the work of the other establishments of the Department, which occupies some eighty-nine pages of the summary of work, compared with a hundred and thirteen devoted to the work of the research associations, only a few examples of the range and importance of the contribution being made to the national welfare and economy can be selected. During the past year the Joint Fire Research Organization has been able for the first time to examine statistics covering a period of five years and thus to examine trends in certain types of hazard, with the result that steps have already been taken to eliminate or mitigate the worst hazards to which some new types of post-war houses appear to be prone. Considerable progress has been made in the study of smouldering in industrial dusts and other materials such as jute sacking and fibre insulating boards, and fresh light has been thrown by a model technique on the importance of ventilation in the development and control of fires. Commenting on the first five years of work of the Organization, the Advisory Council expresses the view that the experiment has been completely satisfactory.

The Building Research Station continued its study of productivity, including an investigation at Norwich of the potential value of a rail-mounted tower crane in house-building, which has led to the development of several special pieces of equipment for handling various building materials and to the design of special equipment, such as turntables, to enable the

crane to negotiate corners. In collaboration with the Forest Products Research Laboratory, the Station has shown in laboratory tests and in small-scale trials that a zinc oxychloride paint or plaster effectively prevents the spread of dry rot. Work on the use of pulverized fuel-ash for brick-making has been pursued on a larger scale in collaboration with the British Electricity Authority; and, besides work on pre-stressed concrete which has established a correlation between behaviour under static and impact loading and on the stiffening effects of walls and floors on structural frameworks, the Station has investigated the soil mechanics of serious breaches in the earth banks of the sea defences in Kent and Essex. The Station has also closely co-operated with the Architects Branch of the Ministry of Education in experimental work on the heating, lighting and acoustics of schools, which has indicated possibilities of economy in fuel by warm-air heating, and a survey of the design and performance of drainage systems is being made with the object of making recommendations for economical and efficient practice.

Under the Food Investigation Organization, wastage surveys have confirmed that the washing of eggs on the farm adversely affects the storage life of the egg. At the Torry Research Station a pilot-scale vertical-plate freezer has been designed which may be suitable for installation on existing vessels, and experiments have indicated that fish can be held in ice for at least three days before freezing without detriment to quality. To meet the needs of the Humber area, a new laboratory was opened in December 1952 as an outstation of the Torry Research Station. A mobile refrigerated store has been designed and built which has been used in various producing areas in England and Scotland for precooling strawberries, raspberries and plums immediately after harvest, to improve the keeping qualities, and for storing Cornish broccoli and spring cabbage; and means of reducing the costs of the two main methods of suppressing the sprouting of stored potatoes are being investigated, for both the use of growth-inhibiting vapours, such as amyl alcohol, and cool storage, are still too expensive. Basic investigations include studies of the properties of the proteins of connective tissue and of the fibrous protein, as it exists in tissues, of the lipids, proteins and soluble extractives of fish flesh, of the chemistry of wood smoke and of the chemical substances which are responsible for the browning, caused by certain enzymes, which occurs when some living plant tissues are injured. The volatile substances produced by apples during storage are being identified and estimated, and a survey is being made of the ascorbic acid content of the chief herbage plants.

In the Forest Products Research Laboratory high priority has been given to the production of preservative-treated plywood. New projects in timber mechanics include investigations on the strength of struts of the type used in light constructional work; on the effect of the construction of plywoods on their strength; and on the design, performance and working stresses of plywood components in structures. General biological work on the common furniture beetle, and further work on the production of hardboards from tropical timbers continued, while studies of beech, oak and Corsican pine showed that at a given humidity the Young's moduli decrease linearly with increase of temperature, although at 90 per cent relative humidity there is evidence of a curvilinear relation.

Increased calls for advisory work continued to be made on the Fuel Research Station, which is exploring the possibility of a relation between the rank of a coal and the germanium content as part of a survey of the occurrence of germanium. Work on the production of metallurgical coke by carbonizing blends of coking coals with other coals continued, and also the study of the factors responsible for changes in the flow properties of residual fuel oils during storage. Work has been started on the adsorption of argon at low temperatures on the iron catalysts used for the Fischer–Tropsch synthesis to see if there is any relation between pore structure and catalytic activity. Efficiencies of up to 90 per cent have been obtained in the removal of sulphur dioxide from flue gas in a scrubber containing a carbon packing in which the grid surfaces are thoroughly wetted at low rates of liquor circulation and the liquor is aerated through a ceramic filter-candle; further work was also carried out with three types of combustion chamber intended to permit the use of solid fuel in industrial gas-turbines. Work at the Station has shown that emission of smoke from forced-draught or natural-draught hand-fired steam boilers can be prevented by the correct use of secondary air, and for the natural-draught types a special fire door has been developed for the purpose.

The publication of maps and memoirs by the Geological Survey has been retarded by the current necessity for concentrating on problems connected with coalfield development, mineral and water resources and hydro-electric schemes; but some progress has been made in acquiring new basic geological data and applying new methods of research. Field work included a survey of the causes and results of erosion in the valleys converging on Lynmouth in North Devon, and the drilling of a borehole on the advice of the Survey averted the necessity for an expensive scheme of piped water supply to Holy Island; in the search for uranium, field investigations of ore deposits were undertaken by officers of the Atomic Energy Division of the Survey in most of the British Colonies, some Commonwealth countries and other territories overseas. A survey of water resources in areas of Bunter Sandstone in Nottinghamshire showed that, in the northern part of the county, reserves will permit a further daily abstraction of about 19 million gallons, and areas of saline water infiltration in chalk areas in Yorkshire and East Lincolnshire have been similarly defined.

In mechanical engineering research the year has been one of consolidation; but the report refers to the work on the fatigue strength of notched and unnotched high-strength aluminium alloys which is nearing completion and to the installation of laboratory equipment for work on materials subjected to high temperature and complex stresses. Experiments on pitot-tubes in water have established that flutter at higher speeds affects the tube coefficient, but can be virtually eliminated by use of a supporting strut with an aerofoil instead of circular section. Two closed-circuit research rigs have been designed for investigating flow conditions in centrifugal and axial flow pumps up to 25 h.p., and a critical analysis of existing formulæ used for scaling-up the performance of model water-turbines has indicated that Reynolds-number corrections should be applied to only part of the losses. A comprehensive programme of research on lubrication and wear had particular reference to the operation of bearings at higher speeds and the elucidation of fundamental aspects of the wear

process. Re-calibration of precision measuring equipment transferred from the National Physical Laboratory was completed during the year, and a new portable instrument for measuring profile errors on large marine gears was completed and used on several sets of gears for the Admiralty. Work on the design and development of the prototype apparatus for torque and vibration measurements on small high-speed precision ball-bearings was nearing completion. The properties and behaviour of materials under hydrostatic pressure were also being investigated, while, besides a survey of literature on heat transfer during 1948–50 which was being published, further surveys are planned, as well as a detailed survey of all data on natural convection from vertical surfaces.

The Pest Infestation Laboratory completed its biological studies on the spider beetle, *Ptinus tectus*, and its investigation of the fauna of dry birds' nests, which indicated that old nests built on or inside houses constitute a frequent point of entry for such pests as the carpet beetle. A detailed investigation of the storage of grain under air-tight conditions was in progress, and recommendations, based on experimental work, for a twice-weekly application of 5 per cent DDT dust gave virtually complete control of emergence of blowflies from refuse when adopted by the borough council concerned. The effect of insecticides and fumigants on the carbohydrate metabolism of insects was being studied, and a modified method of paper chromatography was developed for the micro-analysis of mixtures of pyrethrins and their derivatives.

The main contribution of the Radio Research Organization is in the field of wave-propagation, where its investigations have led to a better understanding of the mechanisms of transmission between transmitter and receiver and of the properties of the medium traversed. Ionospheric investigations have included the study of propagation conditions over routes extending to many thousands of kilometres and hourly measurements of ionospheric conditions at seven observatories distributed over the world, while the data accruing from the study of high-frequency noise during 1945–51 have been reviewed in a special report. The Station is also concerned with the properties of materials of importance in the technique of telecommunications. The new Water Pollution Research Laboratory at Stevenage, Herts, is expected to be ready for occupation by the middle of 1954, when the work at present carried out at Watford, Garston, Birmingham and Coventry will be transferred to the new building. The Advisory Council stresses the growing importance of the work on water pollution, and instances the anxiety caused by the condition of the Thames Estuary, to the study of which the Laboratory is at present devoting much of its resources. Other work has been concerned with the effects of customary processes of water treatment on the removal from water of small quantities of radioactive substances, particularly those used in medicine and industry, the treatment of sewage by the process of alternating double filtration, the anaerobic fermentation of liquor from the kiering of cotton, the effects of cyanides on the treatment of sewage in percolating filters, and the development of a standard method for assaying the toxicity of industrial wastes to fish. The work of the Intelligence and Information Division, to which special attention was directed by the Advisory Council in last year's report, receives this year a special section in the "Summary of Work", stress being laid on the work on the conservation of raw materials and the development of programmes of research on human factors in industry, production economics and industrial engineering.

New or revised terms of grant were offered to seven research associations during the year, as well as to the Research Committee of the Furniture Development Council, and the British Whiting Federation Research Council, while the Commonwealth Mycological Institute is to receive £1,000 a year for the five-year period from April 1, 1953, for the maintenance and expansion of its collection of fungi of industrial importance until the appointment of an additional mycologist, and thereafter £2,000 a year. The British Cast Iron Research Association receives a further block grant of £20,000 for the period July 1, 1953–June 30, 1954, and an additional £100 for each £100 from industry on the same terms as for the previous five years. Its work on the influence of gaseous elements in cast iron continues to increase: a theoretical study of factors influencing the oxygen content has been completed and work commenced on both oxygen and hydrogen. A comprehensive account has been prepared of the effects of composition and structure on electrical resistivity, and progress made in improving methods of sampling and analysis. Negotiations were in progress for the manufacture of the extractor unit specially designed to control respirable dust from pedestal grinding wheels, and work on the protection of marine propellers from corrosion and also of water mains buried in corrosive soils has reached the development stage.

For the period January 1, 1953–December 31, 1957, the British Ceramic Research Association, which now covers all the activities of the ceramic industry, is to receive a block grant of £30,000 a year, conditional on £80,000 from the industry, and an additional £100 for each £100 from industry up to a maximum of £20,000. A major task of the Association continues to be the definition and control of the properties of the raw materials used in the pottery industry, and attempts are being made at the direct determination of the constituent elements in a clay. The principles involved in a satisfactory system of controlling the rheological properties of the slip have been worked out and put into operation in several works, and much attention has been given to the study of chrome–magnesite and magnesite–chrome bricks for steel furnaces. In long-term work on the design and operation of a homogeneous extruded column, a device has been developed for controlling the moisture content of the clay by means of a valve operated by the thrust on the screw, and this device has proved satisfactory in works trials. For the British Coal Utilization Research Association a block grant of £45,000 a year was made for the period January 1, 1953–December 31, 1957, conditional on £190,000 from industry, and a further £50 for each additional £100 from industry up to a maximum of £30,000. Early in the year the new laboratories for work on domestic appliances were opened, and here an electrostatic precipitator has been developed through which the whole flow of flue gas can be passed without appreciable drop and which deposits all smoke on light concentric cylinders where it can be weighed. Work on cyclone combustion has aimed at discovering principles of design for a combustion chamber of suitably limited size to operate under pressure with a gas turbine. Investigations on the effects of coal properties on boiler

performance, using a chain-grate stoker, have been completed, and work on gas producers has endeavoured to ameliorate tar deposition and improve the quality of gas.

The new block grant for the British Gelatine and Glue Research Association for 1953–55 is at the rate of £6,000 a year, conditional on £8,000 from industry, with a further £100 for each £100 from industry up to a maximum of £4,000. The Association, the laboratories of which have only been operating during the past three years, has developed a new technique for fractionating gelatin, based on the solubility in aqueous sodium chloride solution of the complex formed between dodecyl sodium sulphate and gelatin, while an instrument has been designed and produced to check the performance of the testing machine used to grade gelatine and glue as gelling agents. The British Hydromechanics Research Association, the laboratory of which at Harlow was only opened in 1951, is concerned with four main field of work: general problems in fluid flow; centrifugal and allied pumps and turbines; positive displacement machinery; and seals and glands. Useful work on the hydraulic transport of solids and on the design of pump suction pumps has already been carried out, and for the period October 1, 1953–September 30, 1958, the block grant is £9,000 a year, conditional on £18,000 from industry, with a further £75 for each £100 from industry up to a maximum of £9,000.

The research programme of the British Scientific Instrument Research Association has been drastically pruned. Marked progress is reported in the work on anti-glare glass for instrument windows, the use of digital machines in optical computing, the thickness measurement of metal sheaths, humidity-sensitive ceramic elements and the conditions governing the efficient use of diamond-bonded tools. For the period April 1, 1955–March 31, 1956, the block grant will continue at £35,000 a year, conditional on £17,500 from industry, with a further £100 for each £100 from industry up to a maximum of £15,000. The new block grant to the Coal Tar Research Association for the period April 1, 1953–March 31, 1958, will also continue at the present rate of £12,000 a year, but conditional on £45,000 from industry, with an additional £50 for each £100 from industry up to a maximum of £12,000. Current work has included the study of the chemical and physical nature of tar and pitch, the utilization of pitch and of creosote, and service work on such problems as the corrosion of mild-steel distilling equipment by hot tar and tar oils, or the formation of deposits in tar stills. Studies on the chemical composition of a pitch-coking distillate, the electrophoresis and ultra-centrifuging of tars and solutions of pitch were in progress, and the low-temperature non-destructive hydrogenation of tar oils has been extended to the production of tetrahydronaphthalene and *trans*-decahydronaphthalene from crude and refined naphthalene, and the removal of sulphur from anthracene and phenanthrene.

Besides these grants, two special grants were made towards heavy capital expenditure. One of them, not exceeding £100,000 and conditional on special contributions of £200,000 from industry, was approved towards the new laboratory at Leatherhead of the British Electrical and Allied Industries Research Association where, besides its main work on the generation of electrical energy, the economical transmission and distribution and the most efficient utilization of such energy and the reliability of equipment, the Association carries out a substantial amount of fundamental research, in which a general theory of electrons in dielectrics has been established so far as concerns the method of approach; and work on the relation between permittivity, loss angle and structure has shown the importance of texture in determining the properties of a dielectric. In rural electrification, good progress is reported in research on the drying of grain, seeds and fodder crops, and promising results were obtained in preliminary work on the destruction of pests in grain by high-frequency electric fields. The second grant, also not exceeding £100,000 and conditional on not less than £300,000 from industry, was to the British Coke Research Association towards a full-scale oven plant to test the possibilities of producing satisfactory coke from blends of coal, including those individually unsuitable.

During 1952 there were forty-one research associations, with an income of four million pounds, of which £1·3 millions came from the Department, compared with twenty-one research associations with an income of £480,000 (£178,000 grant) during 1939. Of the work of the remaining associations, no more can be said here than brief comments on four associations. The formation of the Rayon Section of the British Cotton Industry Research Association in 1928 has contributed largely to the ability of the industry to deal with the new man-made fibres, and the Association has contributed a considerable number of successful devices to improve output or conditions. The Hosiery and Allied Trades Research Association has devised a practical means for synchronizing the rate of feed of yarn to hosiery knitting machines, and a method of impregnating chrome leather with rubber latex, devised by the British Leather Manufacturers' Research Association, permits leather to be waterproofed without losing its ability to transmit water vapour. The Printing, Packaging and Allied Trades Research Association has been concerned with developing the techniques for measuring and comparing odour with the object of assessing the possibility of odour contamination from materials used in making the packing.

The annual report of the Department thus presents a picture of widely varied activities affecting almost every aspect of industry and national welfare. It is a picture, too, of increasing co-operation and of an organization which is intimately interlocked with the national research effort in Great Britain as a whole, whether concerned with defence, the development of atomic energy or the fundamental research in progress at the universities. The wise direction of this expenditure of effort is a matter of continuing concern to industry and the universities as well as to Parliament, and the present annual report goes far to provide a basis for sound judgment as to the wisdom with which the Department's activities are planned and its objectives selected. The very complexity of the relations disclosed, however, demonstrates the shortsightedness and wastefulness of some of the reductions in expenditure imposed on the Department during recent years. The material supplied in this latest annual report should be used by scientific workers and industrialists to make sure that in future the activities of the Department are guided and modified by views of a sufficiently long range to avoid wasteful repercussions and secure that the nation reaps some return from activities to which it has once been committed.

OBITUARIES

Dr. G. P. Bidder

George Parker Bidder died on December 31, 1953, in his ninety-first year—for many years president of the Marine Biological Association, sometime president of Section D (Zoology) of the British Association, secretary of the Linnean Society during 1928–31 and vice-president in 1924 and 1932, a founder of the Association of British Zoologists, and a distinguished authority on the sponges. He was a man to whom more than one generation of biologists were indebted for counsel and for help. At no time a professional scientist, he was perhaps the last of his kind—that of the great amateur biologists of the past century.

He was the grandson of his namesake, the famous 'calculating boy', and had something of the same remarkable quality of memory. At the first council of the newly formed Society for Experimental Biology in 1923, the secretary disclosed that the blackboard on which was written the constitution had been wiped clean without any record in writing. Dr. Bidder adjourned the meeting for fifteen minutes: he then wrote out from memory the entire constitution; and the secretary then read the minutes.

Bidder had his first taste of biology as a boy at Harrow, a taste confirmed when in 1881 he spent a year under Ray Lankester at University College, London. He then went up to Trinity College, Cambridge. This was just after the tragic death of Francis Maitland Balfour at the height of his power as comparative anatomist and embryologist: as Bidder once said, "a great and exciting laboratory—ruled by a ghost". On leaving Cambridge in 1886 he occupied the University Table at the Stazione Zoologica, at Naples. So began his long association with marine biology.

In 1899 he married Miss Marion Greenwood, a biologist who had already done elegant work on the physiology of *Hydra*. Many Cambridge biologists remember with fresh regret her death in 1932. For a few years they lived at Plymouth, while he worked at the Plymouth Laboratory in close touch with Dr. E. J. Allen. They settled in 1902 at Cavendish Corner, Cambridge. Unfortunately, he soon became seriously ill and was a semi-invalid for more than ten years. But he was not a man to be put down by circumstance, and after his illness he returned to assume the active position in biological affairs which he retained for the rest of his long life.

He did this in his own way. By present standards he was unconventional—or it were better to say that he had the patrician ability to make his own system of conventions. Few young biologists to-day would suddenly decide to buy a Neapolitan hotel—'Parker's'—as he did in 1889; and to run it successfully and for some time. Also few to-day could happily and successfully organize a life in which the active day started towards evening, and one did not retire until the early hours of the next morning. But unlike the Watertons and the Frank Bucklands of the past century, he used his freedom from convention and his independent and disinterested position to seize the moment to do things essential for biological advance—things that could not be done by the professional scientist, and which can never be done simply and in time by official bodies. In the early days of the Plymouth Laboratory it was scientifically necessary to buy a vessel for fishery work. There were official difficulties about doing this. Bidder himself borrowed the money to buy a ship, hired it to the Association for the work, and ultimately arranged for it to be sold at a profit—characteristically using the proceeds to found the Ray Lankester Investigatorship. Such long-sighted and timely action was characteristic of his life. It was action of this sort by him that perhaps more than any other single factor helped the Stazione Zoologica at Naples to survive two world wars and to regain its present great position in international science.

Two major scientific periodicals, the *Quarterly Journal of Microscopical Science* (of which he became for long the owner) and the *Journal of Experimental Biology*, owe their continued existence to his help and wise advice. These were only some of his many-sided activities. He was no narrow specialist, but a man of culture with major interests spreading far outside biology. For many years he was managing director of the Cannock Chase Colliery.

Bidder enjoyed conversation and scientific speculation; but his interest was in real phenomena rather than ideas alone. For that reason, his scientific contributions were not just the elegant speculations of a dilettante, but a real influence on current biological thought; particularly those concerned with the form of organisms. Though, to the regret of many of his friends, he was never elected into the Royal Society, he will, I believe, prove to have been one of the most interesting figures of early twentieth-century science. He was a lasting example of how much good can be done by the individual action of a shrewd, kind, disinterested and able man. More than one generation of biologists learnt from him the value of approaching research, not in a spirit of narrow specialization but in one which is best summed up in a characteristic opening phrase of his own—"It has often occurred to me to wonder . . .".

C. F. A. Pantin

Mr. S. F. Ashby

Sydney Francis Ashby was born on December 31, 1874, at Rockferry, Cheshire. His father was a gifted artist and his mother the daughter of a naval officer. He studied first at the University of Liverpool, then at Edinburgh, where he graduated. Afterwards he proceeded to the Universities of Halle and Göttingen and spent some time in Denmark studying the bacteriology of water. He returned to England and worked at the Rothamsted Experimental Station as Carnegie Research Fellow under Sir Daniel Hall. While there he was offered the post of microbiologist to the Government of Jamaica, which he accepted in 1906. He married in January 1910 Miss Cork, daughter of Mr. William Cork, supervisor of revenue, and returned to England in June 1910. He studied in London until 1912, when he went back to Jamaica, specifically to see what could be done about the dreaded Panama disease of bananas, caused by the fungus *Fusarium oxysporum* var. *cubense*, which had been introduced into the Island in 1911. He remained in Jamaica until February 1921, when he was appointed professor of mycology at the Imperial College of Tropical Agriculture, Trinidad. He occupied the chair for a little over five years and returned to England in April 1926 as senior mycologist at the then Imperial Bureau of Mycology. On the resignation of the late Sir Edwin Butler in 1935 he was appointed director of the Imperial Mycological Institute, as it was then known. He relinquished this post in 1939 on retire-

ment. Early in the Second World War he suffered the grievous loss of his son, who was killed in his first operational flight as an observer in the Royal Air Force.

Throughout his scientific career Ashby was thorough and reliable in his work. His first research concerned the assimilation of nitrogen by a soil bacterium. In Jamaica he studied banana diseases and within six months published a valuable account of the work in the Bulletin of the Department in 1912, including a section on Panama disease. For the control of the disease he recommended the isolation of all infected areas, the boundary being set one chain distant from the nearest diseased plant. This treatment was immediately successful and no diseased plants were found outside the boundary line seven to nine months after treatment. Every diseased tree within the affected area was cut down, the stool dug up, and the whole burnt. There is no question but that Ashby's prompt and sound action saved the Jamaica banana industry from ruin and allowed the farmer a means of keeping the disease in check. Unhappily, in the course of years farmers became impatient at having to leave so much land out of cultivation and ultimately Ashby's policy had to be moderated and finally abandoned as the disease gradually got out of control. If his method had been consistently followed the progress of Panama disease would have been impeded much more than it actually was; but in any event, the slowing up of the spread of the disease allowed planters valuable time to consider alternative crops. While in Jamaica, Ashby also published in 1920 notes on a disease of coconut caused by *P. palmivora* and another by *P. parasitica*, and in 1921 an account of sugar-cane mosaic.

Throughout his life he maintained his interest in the important genus *Phytophthora*. In 1925 he became interested in *Stilbum flavidum* on coffee and succeeded in isolating and growing the fungus in culture, proving conclusively that the *Stilbum* is a state of the perfect form *Omphalia flavida*. In 1926 he published with W. Nowell a joint study on the fungi of Stigmatomycoses, a classic paper on a peculiar group of fungi attacking cotton bolls, one of which, since named *Eremothecium asbyi*, proved during the War to be a producer of riboflavin. His next important contribution was on bacterial wilt of bananas, which he showed was due to *Bacterium solanacearum* (*Kew Bull.*, 14; 1927). In 1929 Mr. Ashby visited Dominica in connexion with the outbreak of red rot disease of limes and was able to assure the authorities that the prevalent fungus *Sphaerostilbe repens* had been present in the island since 1911 and was not a virulent pathogen. On his return he concluded an important paper on leaf scald of sugar-cane, naming the causal organism *Bacterium albilineans*. Two papers on *Phytophthora* followed, concerned with the production of sexual organs, and one on *Gloeosporium* strains isolated from bananas. When Mr. Ashby retired in 1939 he had accumulated on behalf of correspondents a vast amount of knowledge about the genus *Phytophthora*; but he did not put this information in print. He died on March 6 after a prolonged period of illness and is survived by his widow and one son. S. P. WILTSHIRE

Mr. J. G. R. Elbo

JOHN GREGERS ROSENSTAND ELBO died on March 11 at Carlton, near Cambridge, at the early age of thirty-one. He joined the staff of the Scott Polar Research Institute in 1946 as part-time assistant in Scandinavian studies, and specialized in the problems of northern Scandinavia, Svalbard and Greenland. He took his degree in modern languages at Cambridge in 1950, and then decided to study for a research degree in Eskimo philology. Meanwhile, the first sign of serious illness had become evident as early as 1948; despite apparently successful treatment his health slowly deteriorated, until in September 1953 the last illness began.

WE regret to announce the following deaths:

Mr. Roland Austin, during 1927–48 joint editor of *Antiquity*, aged seventy-nine years.

Mr. E. Graham Clark, C.B.E., secretary of the Institution of Civil Engineers, a post from which he was due to retire this year (see *Nature*, March 6, p. 427), on April 23, aged sixty-four.

Prof. Methodi Popov, director of the Institute of Biology, University of Sofia, on April 20, aged seventy-three.

NEWS and VIEWS

The Australian Academy of Science

THE Australian Academy of Science was founded in 1952 (*Nature*, **170**, 549; 1952); on February 16, H.M. the Queen, during her visit to Australia, presented a Royal Charter to the officers and Council-elect of the Academy. This is the first time in nearly 300 years that a reigning British sovereign has founded a scientific society, the only previous occasion being the founding of the Royal Society of London by Charles II. The names of the Council-elect are announced in the *Australian Journal of Science* for February; these have to be ratified at the first general meeting of the Academy during April 6–7 when twenty-seven new Fellows will be elected. Also to be ratified at the meeting are the nominations of the following officers: *President*, Prof. M. L. Oliphant; *Treasurer*, H. R. Marston; *Secretary* (*Physical Sciences*), Dr. D. F. Martyn; *Secretary* (*Biological Sciences*), Dr. A. J. Nicholson.

New Zealand Science Review

To commemorate the recent visit of H.M. the Queen and H.R.H. the Duke of Edinburgh, the January issue of the *New Zealand Science Review* is a "Royalty and Science" number (**12**, 1; 1954). After a brief editorial article welcoming the Royal couple, the address entitled "Science and the Scientific Worker" given by the Duke before New Zealand scientists on January 13 is reported in full. This meeting was organized by the Royal Society of New Zealand, with its president, Dr. W. R. B. Oliver, in the chair. During his speech, the Duke conveyed greetings to the Royal Society of New Zealand from the Royal Society of London and the British Association for the Advancement of Science. Then follows an informative article reviewing the history of the interest shown by royalty in science. I. D. Dick contributes a more specialized article on "Royalty and Science in New Zealand". It was also a happy

thought to include in this number the complete presidential address delivered by the Duke before the British Association meeting in Edinburgh in 1951, for that address is still recalled by many as one of the most forcible speeches made in recent years. Dr. Oliver gives a historical account of the Royal Society of New Zealand, which was founded in 1867 as the New Zealand Institute. In the same issue it is announced that publication of a new series of *N.Z. Science Abstracts* is to begin shortly, and that it is hoped that an abstract will appear within a month of the publication of each paper.

Memorial to Dr. W. G. Duffield at Canberra

A memorial tablet to the late Dr. W. G. Duffield was unveiled by his daughter Miss Joan Duffield, in St. John's Church of England, Canberra, on January 3. Dr. Duffield was the founder and first director of what is now the Commonwealth Observatory, Mt. Stromlo, Canberra, holding office from 1924 to the date of his early death in 1929 at the age of fifty years. The service was held in the presence of many who had been associated with the early development of Canberra. Lessons were read by the present director and Commonwealth Astronomer, Prof. R. v. d. R. Woolley, and the Right Rev. E. H. Burgmann, Bishop of Canberra and Goulburn, who also dedicated the tablet. Sir Robert Garran, in an address recalling the foundation of the Observatory, referred to the earnestness of purpose with which Dr. Duffield fought for so long and for so hard to realize his life's dream. The tablet, in bronze, displays an engraving of the solar tower telescope at Mt. Stromlo which had been one of Dr. Duffield's major interests.

Botany at Swansea: Prof. Florence Mockeridge

Prof. Florence Mockeridge is retiring at the end of the present session from the chair of biology at the University College of Swansea which she has held since 1921. She was the first holder of the chair and was appointed shortly after the establishment of the College. Naturally she found nothing in existence and she had to lay the very foundations of a Department while simultaneously coping with the demands of teaching. No one who has not had such an experience can readily imagine the sheer hard work involved in such an undertaking, which few of the present generation have had to face and which fewer still will have to face in the future. Our forbears who started scientific teaching in the universities a century ago had none of the complex needs of modern laboratory work to cope with, while students were few and the pace was more leisurely. Prof. Mockeridge devoted her whole energy to the task, which made heavy inroads upon her slender reserves of strength, but she has the unselfish satisfaction of looking back upon a job well done for the benefit of others. She leaves a flourishing organization of well-equipped laboratories, growing numbers of students and an increasing research output.

The Department is primarily botanical with herself as head. Zoology has not hitherto been taken up to full degree standard and was under a zoological lecturer, although Prof. Mockeridge was responsible. Her successor will not have this dual responsibility, as zoology is soon to become independent. Prof. Mockeridge was trained under the late Prof. Bottomley at King's College, London, and did much of the work in investigating the chemistry of his 'auximones', which anticipated the discovery of the auxins. Always young in heart, she has retained a close interest in and sympathy with the work of younger people and has stimulated the research she could no longer do herself. She has been a kind and generous colleague and a wonderful hostess to her fortunate visitors.

Prof. H. E. Street

Dr. H. E. Street, who succeeds Prof. Mockeridge, was born in 1912. He graduated in 1938 at Nottingham as an external student of the University of London, with first-class honours. His first post was on microbiological control work in industry; meanwhile, he enrolled as an evening research student at Birkbeck College under Dr. F. C. Steward. Upon this foundation Dr. Street has built an impressive amount of research on cell metabolism, distinguished for its thoroughness and its grasp of the fundamental problems of chemical physiology. Since going to Manchester in 1949, Dr. Street has established a vigorous research school and has made his laboratory a centre for the study of metabolism in excised roots. He brings to his new post experience as lecturer in the Universities of Nottingham and Manchester, a wide knowledge of modern techniques in plant physiology, and a store of energy and enthusiasm which will be of great benefit in the programme of development which is about to begin in the biological sciences at University College, Swansea.

Katharine Berkan Judd Awards for Cancer Research

The Katharine Berkan Judd Awards of the Memorial Center for Cancer and Allied Diseases and its research unit, the Sloan–Kettering Institute, have been made to the following for their outstanding contributions in the field of cancer research: Dr. Evarts A. Graham, of the Washington University School of Medicine, St. Louis; Dr. George O. Gey, of the Johns Hopkins University School of Medicine, Baltimore; Dr. L. H. Gray, of the Mount Vernon Hospital, Northwood, Middlesex, England; and Dr. Sidney Farber, of the Harvard Medical School, Boston. Dr. Graham's Award is in recognition of his work in cancer surgery and in medical education; he was the first surgeon to remove an entire lung in the treatment of cancer, the patient being still alive to-day twenty years after the operation, and he was also one of the first to work on a possible relationship between lung cancer and tobacco smoke. Dr. Gey's contributions have been in the field of tissue culture, which is important not only for cancer but also for studies of poliomyelitis and other medical research, and in particular he made the long-term culture of human cancer cells known as the HeLa strain, which has been used as a medium for the growth of the polio virus all over the world. Dr. L. H. Gray is a physicist whose speciality is the investigation of the effect of ionizing radiations in normal and cancer cells and the application of this knowledge to radiation therapy. The complementary side of Dr. Gray's treatment by physical methods is represented by Dr. Farber's work in the field of cancer treatment by chemicals; among Dr. Farber's most notable achievements have been his demonstrations that certain chemicals can preferentially damage the cells of certain types of acute leukæmia in children, and this has opened a new field in cancer chemotherapy. The Awards are given in memory of Katharine Berkan Judd, who left a portion of her estate to the Memorial Center for recognition of achievements in the field of cancer, and the recipients, who by

tradition are members of other institutions, are selected by the Sloan–Kettering Division of Cornell University Medical College, the executive faculty of the Memorial Center.

Gulmarg Research Observatory, Kashmir

THE Universities of Aligarh and of Jammu and Kashmir have jointly established a high-altitude research station at Gulmarg in Kashmir, to be known as the Gulmarg Research Observatory, and the Observatory was officially declared open on April 4 by Prof. A. H. Compton, chancellor of Washington University. The Observatory, which is under the direction of Prof. P. S. Gill, head of the Department of Physics, Aligarh, is at a height of 9,000 ft., which, as Prof. Compton pointed out, compares favourably with other high-altitude laboratories such as Mexico City (7,500 ft. and about the same magnetic latitude), Huancayo, Peru (10,500 ft.), Echo Lake, Colorado (10,000 ft.) and Jungfraujoch, Switzerland (11,300 ft.). Work at higher altitudes is also possible at Khillan Marg (11,000 ft.), which is one hour distant, and at Apharvat (14,000 ft.), which is three hours distant. Prof. Compton, who was the first to initiate cosmic-ray studies in India when he carried out cosmic-ray measurements at Tosh Maidan, Kashmir, in 1926, continued: "The latitude and longitude are of special significance in cosmic-ray measurements, in comparing results with those obtained elsewhere. The latitude is that at which most rapid cosmic-ray changes occur with changing latitude. The longitude is close to that where maximum effects of the earth's magnetic field are felt. Comparison of results found here with those from other stations are thus of special significance with regard to the effects of the earth's magnetic field on the primary cosmic rays, a subject of major theoretical interest".

Suffolk Naturalists' Society: Schools Supplement to *Transactions*

THE encouragement of younger people in field natural history and practical biology should not be left entirely to the schools, especially since most observational work and recording has to be done at nearly all times of the year and out of school hours. Apart from this, there are certain institutions, especially local natural history societies, which can obviously offer keen enthusiasts special local information and other facilities which are not to be found elsewhere. Some natural history societies do much to encourage young people by inviting them to meetings and organizing excursions. The Suffolk Naturalists' Society has already done much in this connexion by establishing contact with the local schools and making them members; and now it has taken an even more effective step by publishing for the first time a Schools Supplement to its own *Transactions* (8, Part 3; 1953). The Supplement is intended to be a Schools' Natural History Societies' Journal, in which can be published observations and notes received from member schools—together with suggestions of simple work which schools or young naturalists may undertake. In this first issue is a very practical article on "Field Work on Hedges", giving an easily read account of the plant and animal ecology of hedges. This is followed by an article on "Mice and Voles", which not only informs but is also calculated to inspire and stimulate interest. Two shorter articles follow, on "Moles on Flooded Land" and "The Geology of Suffolk" (Part 2). Practical instructions are then given on how to use a microscope for explaining everyday experiences (in this case, why a nettle-leaf stings). Birds naturally loom large in the field naturalists' interest, so a short article on "Bird Identification in the Field" will prove very useful. There are two reports of biological work by young people: (1) "Investigations into Pellets of the Short-eared Owl" by John Petford; (2) "A Weed Study" carried out by Form II *B* of Halesworth Area School.

This is an excellent journal from all points of view and will undoubtedly do much to encourage the development of interest in natural history in Suffolk and, it is hoped, well beyond the borders of the county. It is to be published twice a year. Further information concerning the objectives of the Suffolk Naturalists' Society and the Schools' Supplement to its *Transactions* can be obtained from the Earl of Cranbrook, Great Glenham House, Saxmundham, Suffolk.

"Standardized Plant Names" in Australia

THE booklet bearing this title is the revised version of a list, originally published in 1942, of standard common names for the more important Australian grasses, other pasture plants and weeds (Bull. No. 272, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1953; n.p.). This new index, which runs to some 132 pages, is a thorough revision of the earlier work, the information having been drawn from all the many reliable sources available. The approved botanical name, its synonyms and the standard common names for each species are given in two lists which permit of simple cross-reference.

Veterinaria Italiana

THE first number of *Veterinaria Italiana*, a review of animal hygiene, prophylaxis and therapy, edited by the General Directorate of Italian Veterinary Services with Prof. Giuseppe Caporale as responsible editor, is an attractively produced journal, issued from the Experimental Zooprophylactic Institute, Teramo (No. 1, January 1954; obtainable from the Institute at c.c. postale N. 20/988; no price). It is a monthly journal containing scientific and practical articles, together with news of veterinary medicine in Italy and the rest of the world. It is intended that the original articles shall have summaries in English, French and German; but in the first issue some articles are in Italian only. This first number is divided into a scientific and a practical part. In the scientific part Dr. L. Badiali writes on the use of *iso*nicotinic acid hydrazide for the prophylaxis of bovine tuberculosis; Dr. A. Mantovini on the culture of canine distemper virus on the chorio-allantoic membranes of eggs; Prof. V. Cilli on animal diseases transmissible to man; and Dr. G. Guarini on the complement deviation reaction for the diagnosis of infective anæmia of the horse. The practical part of the journal contains notes on the therapy of a number of diseases, and the number is completed by reviews of books, abstracts of current veterinary literature and veterinary news. Veterinarians and others interested in the remarkable recent advances in veterinary science will watch the progress of this new journal with interest.

Geographical Studies

WITH the geographical staffs in United Kingdom universities now almost double their pre-war numbers,

and with the publication space of most geographical and closely related journals almost halved as a result of war-time restrictions and rising costs, the emergence of a new journal to cope with the increasing flow of research material now available is not surprising. *Geographical Studies* has been founded very largely by younger geographers to meet this need. The first number, running to some forty thousand words, is well produced apart from an over-reduction of some of the maps and diagrams: it includes research articles from six contributors ranging over a wide field, and also contains notes of geographical interest. Prof. F. K. Hare deals with the boreal conifer zone, while Prof. P. R. Crowe attempts, in an article on the effectiveness of precipitation, a graphical analysis of Thornthwaite's climatic classifications. Dr. G. J. Butland describes the changing land occupancy in southern Chile, and Dr. W. R. Mead, in an article on the language of place, draws some interesting conclusions from a study of two Finnish dictionaries. Geomorphology is represented in an ingenious article from Miss Alice Coleman on the use of the height–range diagram in morphological analysis, and in conclusion J. H. Hubbard contributes some new data on the rainfall of the Gold Coast. It is proposed to issue *Geographical Studies* at least once and possibly twice a year initially. The journal is published from Birkbeck College, Malet Street, London, W.C.1 (price 10*s*.), and inquiries should be addressed there to Dr. G. H. Dury.

British Mathematical Colloquium

The sixth British Mathematical Colloquium was held at Cambridge during April 6–8. Among the hundred and seventy members were Prof. A. Zygmund, at present working in Cambridge, and Prof. L. Schwartz, of Paris, who attended as foreign guest of honour. The first day was devoted to algebra, and the following papers were read: Dr. D. Rees, an aspect of multiplicative ideal theory; Dr. W. Ledermann, some recent work on group characters; Mrs. H. Neumann, Hopf's problem; Dr. C. H. Dowker, dimension of metric spaces. The day devoted to analysis included papers by Prof. Zygmund on Hilbert's transform and its generalizations, Mrs. D. Stone on measure algebras, Dr. H. G. Eggleston on extremal geometrical problems, and Prof. Schwartz on distributions and applications to partial differential equations of hyperbolic type. The geometry (third day) discussed was chiefly algebraic: Prof. J. G. Semple, on enumerative geometry and the method of degenerate collineations; Dr. D. B. Scott, on self-correspondences on algebraic curves and surfaces; Dr. J. A. Todd, on canonical systems on algebraic varieties; Prof. D. G. Northcott, on some local and global aspects of the foundations of geometry. The 'splinter groups' worked with enthusiasm during the intervals available from the main programme, and exchanged much information on problems now being actively investigated. On the afternoon of April 7, a visit was paid to the University Mathematical Laboratory. It is hoped to hold a seventh colloquium in 1955, at the University College of the South-West, Exeter.

Wittgenstein's Philosophical Views

In January 1929, Prof. Ludwig Wittgenstein returned to Cambridge after an absence of more than fifteen years. His return was largely due to the influence of Prof. F. P. Ramsey, who described him as "a philosophic genius of a different order from anyone else I know". Wittgenstein began lecturing in 1930 and continued until 1933. Records of the lectures and subsequent discussions were kept by Prof. G. E. Moore, who has prepared an account of them in a recent issue of *Mind* (**63**, No. 249; January 1954). Among the topics considered were some general questions about language, some special questions in the philosophy of logic and mathematics, as well as behaviourism, solipsism, idealism, realism, "the grammar of the word 'God' and ethical and æsthetic statements". The journal also contains a detailed critical notice of Wittgenstein's book "Philosophical Investigations" by P. F. Strawson.

Leicester Museums and Art Gallery: Annual Report for 1952–53

The forty-seventh annual report of the City of Leicester Museums and Art Gallery for the year April 1, 1952–March 31, 1953 (pp. 44+4 plates; 1953), reflects the steady and continued achievement of this institution. It is an attractive, illustrated production and records faithfully the consolidation that has taken place after the period of considerable reorganization undertaken since the end of the Second World War. The year has been one of close and friendly liaison with local cultural societies, and much extra-mural work has been accomplished in collaboration with the appropriate department in the University College. This means that the Museum buildings are in use on most evenings during the week. The outstanding acquisition of the year was a fine overmantel and oak panelling from Ragdale Hall, Leicestershire, made possible through the generosity of the trustees of the Friends of the Museum Fund.

Non-Destructive Testing Group of the Institute of Physics: Meeting in Birmingham

With the appearance of new techniques for proving or sorting materials and components, some of which are complementary to radiography, the Industrial Radiology Group of the Institute of Physics has changed its name to the Non-Destructive Testing Group, and, under its new title and with extended terms of reference, the Group is holding a summer meeting, which will be on a wider field of physical methods of non-destructive testing than on previous occasions. The meeting will be held in the Chancellor's Hall, University of Birmingham, during July 7–10 and will be open both to members and non-members of the Group, subject to the limit of lecture-room capacity of about three hundred persons. Prof. A. J. Murphy, professor of industrial metallurgy in the University of Birmingham, will give an address on the evening of July 7, and on the succeeding three days six papers will be presented dealing with the following topics: isotope techniques; image intensifiers; diffraction mottling; theory and application of electrical and magnetic methods of non-destructive testing; propagation of elastic waves in solids; and selected topics in ultrasonic testing. Abstracts of the contributed papers will be circulated shortly before the meeting, and the proceedings will be reported in the bulletin of the Group and in the *British Journal of Applied Physics*. Enrolment forms (to be returned by May 31) and further information can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

Earthquakes during January

EARTHQUAKES caused minor property damage on January 12 near Wheeler Ridge, California (magnitude 6), and on January 25 in the island of São Miguel in the Azores. Earthquakes were also reported as 'felt' on January 2 at Arenas del Rey in Spain; on January 17 in Central Honshu, Japan; on January 18 near the west coast of Greece; and on January 27 and 28 near the coast of Guerrero, Mexico. The greatest earthquakes during the month were on January 12 and 13 (magnitudes 7 and 7¼) off the South Island of New Zealand; and other shocks of magnitude 6 and greater occurred, in addition to those mentioned, on January 1 in the Sawoe Sea, on January 20 in the Pacific Ocean south of Mexico, and on January 21 in Kenya. Reports have been received from individual stations at Durham, Lwiro (Belgian Congo), Pasadena, Strasbourg, Toledo and Uccle; and from the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association.

The Night Sky in May

NEW moon occurs on May 2d. 20h. 22m., U.T., and full moon on May 17d. 21h. 47m. The following conjunctions with the moon take place: May 4d. 13h., Venus 3° S.; May 5d. 20h., Jupiter 2° S.; May 16d. 07h., Saturn 8° N.; May 21d. 08h., Mars 1° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Aldebaran on May 19d. 11h., Mercury being 7·2° N.; Venus is in conjunction with Jupiter on May 23d. 12h., Venus 1·5° N.; and Mercury is in conjunction with Jupiter on May 31d. 19h., Mercury 2·2° N. Mercury, in superior conjunction on May 8, is too close to the sun to be seen in the early part of the month; on May 15 and 31 it sets at 20h. 25m., and 22h., respectively, but in the former case this is only 40 minutes after sunset. Its close approach to Jupiter on May 31 has already been pointed out. Venus is an evening star, its times of setting on May 1, 15 and 31 being 21h. 25m., 22h. 05m. and 22h. 30m., respectively. The visible portion of its illuminated disk varies from 0·922 to 0·855, and its stellar magnitude from −3·3 to −3·4. Mars rises at 0h. 10m., 23h. 30m. and 22h. 35m. on May 1, 15 and 31, respectively. It has an eastward motion in the constellation Sagittarius until May 23 when it is stationary, after which its motion is westward. Jupiter sets at 23h. 15m., 22h. 30m. and 21h. 45m. on May 1, 15 and 31, respectively. Its eastward movement from east of ζ Tauri to west of η Geminorum is easily detected. Saturn rises at 18h. 35m., 17h. 35m. and 16h. 25m. at the beginning, middle and end of the month, respectively, and is close to κ Virginis; it can be seen until the early morning hours. No occultations take place during May. The η Aquarid meteors are active at the beginning of the month, attaining a maximum about May 6; the radiant is at R.A. 22h. 24m., Dec. −1°, very close to η Aquarii, from which the shower derives its name. For a long time it was believed that it was associated with the debris of Halley's Comet, but there is now some doubt about this.

Announcements

THE Royal Meteorological Society announced the following awards at the annual general meeting held on April 28: Buchan Prize for the period 1949–53 to Dr. R. S. Scorer for his outstanding contributions to dynamical meteorology; Hugh Robert Mill Medal and Prize for 1954 to Mr. C. K. M. Douglas, for his outstanding contributions to our knowledge of the causes of rain. Darton prize awards were also announced as follows: First Prize, for 1953, Messrs. B. J. Mason and R. Ramanadham. Canadian Prizes for 1953: First Prize, Dr. W. L. Godson; Second Prize, Mr. G. W. Robertson.

THE Worshipful Company of Clockmakers (Candlewick House, 116 Cannon Street, London, E.C.4) has decided to institute an award for outstanding achievement in the field of horology. It will take the form of a gold medal, to be known as the Tompion Medal of the Worshipful Company of Clockmakers, and will be awarded, without regard to nationality, not more than once a year.

COLONEL S. J. M. AULD has been elected president of the Institute of Petroleum for the year 1954–55. Colonel Auld was previously president of the Institute in 1937–38.

MR. K. B. ROSS, who until 1951 was general refineries manager for the Anglo-Iranian Oil Co. at Abadan, and has since then been on the Board of Messrs. Costain–John Brown, Ltd., has been appointed director of production in the Industrial Group of the Department of Atomic Energy at Risley. Mr. P. T. Fletcher, chief engineer of the Ministry of Works, has been appointed deputy director (engineering services) in the Industrial Group.

THE following appointments have been made in the University of London: Dr. F. E. Camps, lecturer at the London Hospital Medical College, to the part-time University readership in forensic medicine tenable at that College; Dr. G. E. Francis, senior lecturer at St. Bartholomew's Hospital Medical College, to the University readership in biochemistry tenable at that College.

THE Committee of Privy Council for Agricultural Research and Nature Conservation has appointed Mr. David Lowe, a prominent Scottish horticulturist, and, after consultation with the President of the Royal Society, Mr. J. N. Ritchie, chief veterinary officer of the Ministry of Agriculture and Fisheries, to fill two vacancies on the Agricultural Research Council.

FOLLOWING the resignation of Mr. A. G. Peacock, for seven years secretary of the Scientific Instrument Manufacturers' Association, Mr. E. D. Hart, for many years with Marconi Instruments, Ltd., and lately with the Equipment Division of Mullard, Ltd., has been appointed deputy director of the Association. Miss G. E. Moss, formerly clerk to the Council, has now taken the position of secretary.

THE Section of Mathematical Statistics of the Australian Commonwealth Scientific and Industrial Research Organization has now become the Division of Mathematical Statistics, with headquarters in Adelaide, and its officer-in-charge, Dr. E. A. Cornish, is now chief of the new Division. The main task of the Division is to provide research workers of the Organization with special help in planning their researches and analysing and interpreting their experimental results.

ERRATUM. In the communication entitled "Proposal for a New Æther-Drift Experiment", by Dr. L. Essen (*Nature*, April 17, p. 734), line 23, for "$\pm$ 1 part in 10^8" read "$\pm$ 1 part in 10^{10}".

EXTENSION TO THE METALLURGY DIVISION OF THE NATIONAL PHYSICAL LABORATORY

THE extension to the Metallurgy Division of the National Physical Laboratory, which was opened by Sir Lawrence Bragg on April 6, has been made necessary by the continuous development of techniques for the examination of the fine structure of metals and by the growth of interest in the properties of materials at very high temperatures. It consists of a two-story building having a total floor area of about 11,700 sq. ft., of which about 5,800 sq. ft. is experimental working space. Its purpose is to accommodate three Sections of the Division—the Ceramics Section, the X-Ray Section and a new Radioactive Tracer Section. Each portion of the building has been designed to meet the requirements of the particular type of work that will be undertaken in it.

The Ceramics Section is on the ground floor and consists of five laboratories and offices, together with a large furnace room. The Section is mainly concerned with the development and production of refractory ware for use under exacting conditions, especially those involving very high temperatures. Facilities are available for crushing, grinding, forming and drying ware, and the furnace room will permit firing on a considerable scale. Space is also available for physico-chemical research and for the needs of specialized experiments and measurements.

Also on the ground floor is a set of rooms for experimental work on the application of radioactive tracer techniques to metallurgical problems. The purpose is to provide a place where these techniques can be applied under suitable conditions to metallic samples, and to assess their value in metallurgical research. The plan underlying the design and equipment of the Section has been to provide facilities for carrying out on metals of all but the highest activity most of the operations normally applied to metals in a research laboratory. The main feature is the foundry, a lofty, well-lit room equipped with melting furnaces, casting equipment, heat-treatment furnaces, a small bar- and sheet-rolling mill and a suitably protected safe for storing active isotopes. Provision has been made to handle active metal in quantities up to about 6 lb. Next to the foundry is a combined workshop and laboratory for metallographic preparations, and next again is a combined chemical and physical laboratory in which chemical analyses and measurements of activity will be carried out. The Section is approached through a semi-sealed door and changing rooms, and is provided with its own air-conditioning system arranged so as to produce a slightly negative pressure. This avoids the possibility of contamination passing to the rest of the building, which is kept at a slightly positive pressure by its own system of air circulation. At selected points in each room, openings to the extract duct are provided, to which extensions to hoods over machines and other equipment may be attached. The rooms are designed to be easily washed down, and have floor ducts and sinks down which all active liquid passes to delay tanks situated under a separate pump house. Separate sinks and drains are provided for non-active liquids (for example, cooling water from pumps, etc.). Warning bells and klaxon alarms are incorporated in the air-conditioning and delay-tank systems to indicate any abnormal feature of their operation.

The upper floor is designed for X-ray diffraction studies of metals and for electron microscopy. The main feature is a single, very large room divided by means of easily removable partitions into a number of cubicles and small laboratories, each of which is intended to contain a single piece of equipment and can be independently darkened. In this way the need of the individual worker to have sole control of his own equipment is combined with adaptability. As a corollary to the use of removable partitions, all services in the Section are carried in a carefully planned system of wall and floor ducts. In addition to the standard services provided throughout the building, there are, in this Section, a circulating system of clean distilled water at 50 lb./sq. in. pressure and 20–25° C. temperature for cooling purposes, and a quiet phase of 230-volt a.c. for apparatus requiring short-term mains stability. Among the pieces of equipment at present installed may be mentioned units primarily intended for standard X-ray techniques, two sets for Geiger–Müller counter work for high-precision measurements of diffraction-line intensities and preferred orientation, one set for work requiring a fine-focus source of radiation, electron microscope and a soft X-ray spectrograph with a recording microphotometer.

In his opening address, Sir Lawrence Bragg referred to the history of the Division, going back to 1901 and to the succession of eminent men who had filled the post of superintendent—Sir Harold Carpenter, Dr. W. Rosenhain, Dr. C. H. Desch, Dr. C. Sykes and, at present, Dr. N. P. Allen. He then went on to say: "I am particularly pleased to be opening the new extension, because all three of its main interests are related to interests of my own. One Section will be devoted to X-ray work, particularly on metals, and I should like to remind you how greatly our country has contributed to this field; in fact, it has been at times almost a British monopoly. Brilliant work on alloys was started by Westgren and Phragmen in Sweden in the early days, but it fell to Owen and Preston here, and to Bradley, who was then with me in Manchester and afterwards came here, to develop the patient study of the structure of alloys which has helped us so much to understand them. Sykes also made contributions to the theory of alloy structure. His experiments and the theories developed by Williams enabled us at Manchester to start the investigations into the order–disorder phenomena, which have exerted a great influence in the study of many other problems of the solid state. The X-ray study of alloys is a rich field to explore, and it is proper that there should be a strong centre of this work at the National Physical Laboratory.

"Another fascinating line which you are to develop here is the application of tracer techniques to problems of metal physics. Metal physics is an extraordinary subject; there is such a vast accumulation of empirical knowledge about the behaviour of metals and so little satisfactory theory behind it. It is an extraordinary position for a subject which has such

immense technological importance. This seems to me to be an ideal activity for the National Physical Laboratory. You will have a special laboratory designed for the purpose and will find by experience how this new technique can be applied. You will be marking a trail which it will be easier for others to follow".

Sir Lawrence then said it must appear he was claiming a finger in every pie; but ceramics are really artificial minerals, and mineral structures have long fascinated X-ray analysts. Minerals are structures of great stability and resistance to change, and these are just the qualities needed for refractories. The juxtaposition of the ceramics and X-ray sections seemed to him completely appropriate, and collaboration between them should be very fruitful. He concluded: "The National Physical Laboratory was founded to keep the country's standards, but it has come to have another function, that of setting standards in experimental investigation. It ought to preserve a judicial and impersonal attitude, contain equipment which is a model of its kind, and be a centre to which one can go for advice, advice which depends upon an impartial review of what is going on all over the country and a readiness to adopt the best ideas whatever their source. With its unique position it has a great part to play in the interchange of ideas and the improvement of standards".

The opening of the main door of the building was performed by Sir Lawrence using a presentation key, made in the Division, of titanium and ornamented with eight other metals, each of which represented some major research or development activity of the Division during the fifty-three years of its existence.

H. A. Sloman

UNIMOLECULAR GAS REACTIONS

A MEETING to discuss the theory of gas-phase unimolecular reactions and its applications to specific reactions was held in the Department of Chemistry, University College, London, on December 4. Dr. N. B. Slater (Leeds) opened the discussion by describing his approach to the problem. If it is assumed that a molecule has a few unstable states (r) of high energy which have lifetimes L_r^{-1}, then if p_r is the probability of the rth state, ω the effective collision frequency per molecule and k the rate-constant,

$$k = \sum_r \frac{p_r \omega L_r}{L_r + \omega} \quad . \qquad (1)$$

At high pressures ($\omega \gg L_r$) the majority of energized molecules will be deactivated, and (1) reduces to (2):

$$k = \sum_r p_r L_r. \qquad (2)$$

The reaction-rate is thus the rate at which a molecule possessing at least an energy E_0 attains a critical configuration. The critical configuration may be taken as a large extension of one of the internal co-ordinates of the molecule. Treating the latter as a classical vibrating system, it can be shown[1] that the rate of reaction is given by

$$k = \nu \exp(-E_0/RT), \qquad (3)$$

where

$$\nu^2 = \frac{\sum_i \alpha_i^2 \nu_i^2}{\sum_i \alpha_i^2}, \quad E_0 = \frac{q_0^2 \cdot}{\sum \alpha_i^2} \qquad (4)$$

The ν_i are the vibration frequencies of the molecule and α_i the amplitude factors, both of which are constants of the molecule in question; q_0 is the critical extension of the co-ordinate corresponding to decomposition, and E_0 the activation energy. No attempt is made in the theory to calculate E_0.

At low pressures the rate of dissociation becomes of the same order of magnitude as the rate of de-activation, and so (1) no longer reduces to (2). However, on the basis of the present theory, it is possible to develop from (1) an expression for k/k_∞, the ratio of the rate at any pressure to the limiting rate at high pressure[2]. Calculations have shown that small molecules should show first-order kinetics only at impossibly high pressures, six or more atoms being necessary to give first-order rates below a pressure of one atmosphere. Dr. Slater showed that the rate as given by (3) and (4) is essentially reproduced at high temperatures by a quantal treatment and that these expressions are little altered by taking account of anharmonicity of the vibrations. The relation of the theory under discussion to that of Kassel and to the transition state theory was described.

Dr. A. F. Trotman-Dickenson (Manchester) gave a critical survey of the experimental field. He stated that, in his opinion, only eight decompositions have been reasonably fully investigated over a large range of pressure, which undoubtedly exhibit quasi-unimolecular behaviour: they are nitrous oxide, di-nitrogen tetroxide, nitrogen pentoxide, fluorine oxide, CH_3NNCH_3, C_2H_6, *cyclo*-C_3H_6, and *cyclo*-C_4H_8. The last two decompositions[3] provide the most straightforward examples of the dependence of a unimolecular rate-constant on pressure. The observations could not be explained on the original Hinshelwood–Lindemann theory. But either the Kassel theory or the Slater theory will fit the results for cyclopropane very well, though the latter theory is much to be preferred because no arbitrary parameters are introduced. A table of the relative efficiencies of various inert gases in maintaining the rates of five reactions was shown by Dr. Trotman-Dickenson, from which it can be inferred that 'kinetic theory' collisions between two complex molecules result in an equilibrium distribution of internal energy between the molecules, whereas equilibrium is attained in only one collision in ten of nitrogen with a complex molecule.

The pyrolyses of alkyl chlorides were discussed by Dr. K. E. Howlett (Bedford College, London). Although two mechanisms—unimolecular and radical chain—have been observed, about ten compounds studied have proved to be pure unimolecular. In each case, critical pressure regions exist, and the number of degrees of freedom required to account for these are reasonable[4]. Inert gases, while having no effect upon the high-pressure rates, are capable in various degrees of restoring the low-pressure rate to the high-pressure value. Ethylene has been found to be the most efficient in transferring energy, and helium the least[5]. Further, the efficiencies appear to be of the same order as predicted by the kinetic theory, in marked distinction to the calculations of C. Zener. It is also observed that the range of efficiencies is never very great. Finally, Dr. Howlett reported that Miss A. M. Goodall has found the inhibited decomposition of trichlorethylene to be a homogeneous second-order, non-chain process, in accord with Slater's predictions for small molecules.

Dr. F. J. Stubbs (Oxford) dealt with the pyrolysis of hydrocarbons. A limiting reaction-rate in the presence of inhibitors is observed, which is independent of the nature of the inhibitor and identified with a molecular process. The rates are found to be pressure-dependent. Two modes of decomposition are found, as typified by ethane and *n*-pentane. In the former case the activation energy is independent of pressure, and there is a single transition from second to first order as the pressure rises. In the latter case the activation energy falls as the pressure rises, and the reaction order changes from two at low pressures to one, then towards two and finally reaches one again at high pressures. For compounds like *n*-pentane, the rate can be divided into two terms each corresponding to a unimolecular reaction, one of which (predominant at low pressures) is characterized by a high E and A, and the other (predominant at high pressures) is characterized by a low E and normal A [6]. In the latter case, it is suggested that the activation process is essentially confined to a C—C bond, whereas, in the former, C—H activation is involved as well. This is assumed to give rise to a multiplicity of reaction paths, corresponding to the carbon nucleus being surrounded by a mobile sheath of hydrogen atoms. The magnitude of A and E can be interpreted on this basis.

The pyrolysis of mercury alkyls in the presence of nitric oxide as a chain inhibitor was described by Dr. B. Gowenlock (Swansea). Under these conditions both a nitroso compound and an oxime were obtained in the products[7]. In the case of dimethyl mercury[8] the activation energy was about 6 kcal. mole^{-1} less than the energy required to break both bonds, and this is considered to be the energy required to break the first Hg—C bond; the frequency factor was about 10^{13} sec.$^{-1}$. However, with di-*n*-propyl mercury[9] and di-*iso*propyl mercury[10], E corresponded to the energy required to break the two bonds and A was of the order of 10^{15} sec.$^{-1}$. The increase in the frequency factor corresponds with the spreading of the activation energy over two bonds.

Further evidence in this connexion was provided by Dr. E. Warhurst (Manchester). While diphenyl mercury behaves like the dipropyl mercury compounds, phenyl mercuric chloride and bromide show the same type of behaviour as dimethyl mercury. This series of compounds shows an interesting type of behaviour as the number of oscillators in the reacting molecule increases. Further evidence for frequency factors of 10^{14}–10^{16} sec.$^{-1}$ coupled with 'high' activation energies is provided by a series of carbonyl-containing compounds studied by M. Szwarc and his co-workers.

Dr. H. O. Pritchard (Manchester) pointed out that an explanation of the observed differences in behaviour of dimethyl mercury and di-*iso*propyl mercury upon pyrolysis would probably have to await a further interpretation of the vibrational spectra of mercury di-alkyls. Again, uncertainties in the strengths of C—H bonds make it possible that the activation energy for the di-*iso*propyl mercury decomposition may be significantly greater than the sum of the energies required to break the two Hg—C bonds. Such behaviour is actually observed in azomethane, where the activation energy is approximately double the sum of the dissociation energies for the two N—CH_3 bonds. However, in this case it is reasonable to assume that the activation energy is all concentrated in one N—CH_3 bond, since the frequency factor is only 10^{14} sec.$^{-1}$.

The case of dimethyl mercury was referred to again by Dr. L. H. Long (Exeter), who reported an activation energy for the unimolecular decomposition in excellent agreement with that of Gowenlock, although obtained by a different technique. As was also noted by the previous two speakers, the frequency factor tends to rise with increasing pressure.

Dr. J. O. Hirschfelder (Wisconsin) emphasized the importance of a theoretical calculation of energy transfer at surfaces. There is strong experimental and theoretical evidence to indicate that molecules obtain their energy of activation by collision with the walls rather than with other molecules in the gas phase. This would require a considerable modification of the Slater theory and lead to somewhat different results. In connexion with the Eyring theory of bimolecular reaction-rates, Dr. Hirschfelder underlined the necessity of allowing for rotation in the activated complex. With the H_2I_2 complex, for example, unless this factor is allowed for, the rate comes out too small by a factor of about 1/300. A value in better agreement with experiment is obtained if rotation is considered. It is to be hoped that the future development of reaction-rate theory will include both unimolecular and bimolecular reactions in a uniform treatment.

Some results of experiments on the pyrolysis of alkyl bromides carried out by Drs. J. H. S. Green and P. J. Thomas and Mr. G. D. Harden were described by Dr. A. Maccoll (University College, London)[11]. Whereas secondary and tertiary bromides decompose cleanly by a unimolecular mechanism, the primary compounds decompose by a mixed chain–unimolecular mechanism, the chain part of which, however, may be eliminated by the use of cyclohexene as an inhibitor. In all cases of unimolecular decomposition, the frequency factors are of the order of 10^{13} sec.$^{-1}$. An interesting series is that of the normal bromides, for which (apart from ethyl) the activation energy is constant and the rates appear to approach a limiting value as the chain-length increases.

Prof. H. C. Longuet-Higgins (King's College, London) outlined a quantal attack on the problem of reaction-rates, which he has been developing in collaboration with Mr. P. W. Higgs. In the case of a molecule capable of dissociation and which cannot be considered as being in a pure quantum state, the outward flux across a given value of a co-ordinate may be calculated. For an assembly of simple harmonic oscillators in thermal equilibrium, such a calculation leads to the quantal expression for the reaction-rate. It is found that at high temperatures (the classical limit) equation (3) is recovered, but at intermediate temperatures the rate expression departs from (3); in particular, a finite rate is predicted at 0° K. It was suggested that perhaps the theoretical criterion of reaction $q > q_0$ would need to be re-examined in the light of the experimental criterion, which is the appearance of new chemical species. The full solution of the problem in the case of many degrees of freedom is not yet available.

The flexibility of the Eyring treatment in its ability to account for a wide variation in ν was referred to by Dr. B. Atkinson (Imperial College of Science and Technology, London). High value of ν can be interpreted in terms of a 'loosening' of the molecule in the transition state and low values in terms of a 'stiffening'.

A number of points emerged as to the present state of knowledge of unimolecular reactions. In the first place, there now seems to be a large number of well-established gas-phase unimolecular reactions. Secondly, experimental investigations of the low-pressure region have enabled relative collision efficiencies for energy transfer to be estimated. Thirdly, there appears to be quite a wide range of frequency factors. Fourthly, it is desirable to extend the theoretical treatment along quantal lines. Finally, recognition of the possible multiplicity of reaction paths may be a fruitful line of approach.

The meeting closed with an expression of gratitude to Prof. C. K. Ingold, of University College, London, through whose interest the conference was made possible.

[1] Slater, N. B., *Proc. Roy. Soc.*, A, **194**, 112 (1948).
[2] Slater, N. B., *Phil. Trans.*, A, **246**, 57 (1953); *Proc. Roy. Soc.*, A, **218**, 224 (1953).
[3] Pritchard, H. O., Sowden, R. G., and Trotman-Dickenson, A. F., *Proc. Roy. Soc.*, A, **217**, 563 (1953); **218**, 416 (1953).
[4] Howlett, K. E., *J. Chem. Soc.*, 3695, 4487 (1952).
[5] Howlett, K. E., *J. Soc. Chem. Indust.*, 1175 (1952).
[6] For all references see Peard, M. G., Stubbs, F. J., and Hinshelwood, C. N., *Proc. Roy. Soc.*, A, **214**, 471 (1952).
[7] Chilton, H. T. J., and Gowenlock, B. G., *J. Chem. Soc.*, 3232 (1953).
[8] Gowenlock, B. G., Polanyi, J. C., and Warhurst, E. *Proc. Roy. Soc.*, A, **218**, 269 (1953).
[9] Chilton, H. T. J., and Gowenlock, B. G. (to be published).
[10] Chilton, H. T. J., and Gowenlock, B. G., *Trans. Farad. Soc.*, **49**, 1451 (1953).
[11] Green, J. H. S., Harden, G. D., Maccoll, A., and Thomas, P. J., *J. Chem. Phys.*, **21**, 178 (1953).

SCIENTIFIC AND TECHNICAL DOCUMENTATION IN TURKEY

TECHNICAL Assistance projects in Turkey, some of them operating, others to come into operation if and when funds are available, cover a great variety of subjects: public administration, economic research, civil aviation, statistics, maternal and child health, diseases control, water resources development, oil resources development, fisheries development, hydrogeology, seismology, and various others. Bibliographical and documentation services, needed by many of them, are also included.

The National Bibliographical Centre is one of three Unesco projects under the Expanded Programme of Technical Assistance in Turkey. It was set up in 1952, with the assistance of two library experts: a specialist in bibliography, from France, and a specialist in documentation, from the United Kingdom. The Centre is housed at the National Library in Ankara and, apart from co-operating with Technical Assistance projects, maintains close contact with government departments, university faculties, scientific societies, educational institutes, research stations, industrial undertakings and, of course, other libraries.

The main objective of the Bibliographical Centre is to assure the availability of information to all Turkish programmes for scientific, technical and economic development. This emphasis on Turkish affairs does not, however, preclude it from collaborating in a system of international exchanges of scientific information and so render valuable service to the region, and to the world.

With financial aid earmarked for the purpose by Unesco Technical Assistance, the Centre brought together a much-needed collection of handbooks, monographs, bibliographies, catalogues and other library tools in many different languages. This useful reference library, open to *bona fide* research workers, has meanwhile become indispensable to staff and readers alike.

Under its regular programme, Unesco has established in Istanbul a branch office of its Middle East Science Co-operation Office, the headquarters of which are located in Cairo. The Istanbul Office acts as an outpost of Unesco in Turkey, and among its activities has been the *ad hoc* supply of scientific information requested by Turkish scientific workers. The United States Information Service offers similar facilities within the range of United States sources. The Middle East Science Co-operation Office in Cairo issues an abstracting journal in the English language which covers the Middle East countries and includes several periodicals published in Turkey.

Fuller coverage of Turkish periodicals in the pure and applied sciences, technology and so on, is now provided by "Türkiye Makaleler Bibliyografyası" ("Bibliographie des articles parus dans les périodiques turcs"), issued by the National Bibliographical Centre. It is published at irregular intervals, is arranged by Universal Decimal Classification numbers, with the titles of articles in Turkish and French, and has an author index. Translations or abstracts of specified papers, and microfilms of the original texts, are supplied on request.

As a means of meeting and co-ordinating incoming demands for foreign articles which may be available in Turkey, the Bibliographical Centre has compiled, and keeps currently up to date, a union catalogue of foreign periodicals in Turkish libraries. It is now in its second edition.

Scientific papers published in other journals are obtained as microfilms from abroad, against payment in Unesco coupons or, mostly, on an exchange basis. The first exchange arrangement was concluded in March 1953, between the National Bibliographical Centre in Ankara and the Centre National de la Recherche Scientifique in Paris. This places at the disposal of Turkish men of science a substantial part of the world's scientific literature, and makes Turkish contributions available to scientists in the West. The microfilm laboratory at the Turkish National Library, previously almost exclusively engaged on the copying of manuscripts, has adjusted itself admirably to the new tasks, and a microfilm camera and microfilm reading machines have been imported from Britain.

Approach to documentation may be two-fold—short-term and long-term—one taking care of immediate needs and the other making provision for potential requirements. It has been the policy of the Centre to prepare for both, trying to do justice at the same time to border-line cases, of which there are many.

Inquiries for documentation were received from quarters interested in subjects as widely apart as: palæontological research; fish culture and fish industry; methods of preserving and utilizing agricultural products; and industrial accidents and workmen's compensation—to mention only a few. It had, moreover, been agreed between Unesco and the World Health Organization, also represented in Turkey, that every possible help should be given to medical libraries and medical documentation in Turkey. The Bibliographical Centre was also called upon to act as liaison for a direct approach between research and study projects in Turkey and their opposite numbers elsewhere. An agricultural research

station was referred to the Food and Agriculture Organization; an industrial information unit put in touch with the Department of Scientific and Industrial Research; a chemistry department with the Gmelin Institut für Anorganische Chemie; and a government agency with the International Organization for Standardization. Such liaison has been essential, for, through it, has been created a broader footing for scientific and technical documentation; in the terms of Technical Assistance, "the activity started on the right lines". LUCIA MOHOLY

LATERITES AND BAUXITES OF ANTRIM

THE first memoir to be published by the Geological Survey of Northern Ireland*, prepared by Mr. V. A. Eyles and other workers, will be widely recognized as a contribution to the geochemistry and mineralogy of laterite and bauxite of outstanding importance and permanent value. Equally welcome will be the promised companion volume on the detailed geology of these rocks as they occur in the Interbasaltic Horizon of Co. Antrim. The present work deals with the nature of the chemical changes concerned in the process of lateritization and of the composition of the Interbasaltic lateritic rocks themselves. The latter were formed during a prolonged pause in the Tertiary volcanic activity responsible for the Antrim basalts. At an early stage in this Interbasaltic period there was a brief recrudescence of activity characterized by the eruption of highly silicic lavas. Intense erosion followed, with removal of most of the rhyolites and complementary deposition of thin sediments largely composed of rhyolitic debris. Towards the end of the lateritization period a thin coal seam was formed from the vegetation that flourished over the area. An interesting note records that Dr. J. B. Simpson finds the floral remains from a coal associated with bauxite near Portrush to be of essentially the same age as the corresponding horizon in Mull, to which he is inclined to ascribe a late Miocene or early Pliocene age. This is so much later than has hitherto been thought probable that the publication of Dr. Simpson's palæobotanical researches will be eagerly awaited. The Interbasaltic period was terminated by the outpouring of the Giant's Causeway and later basaltic flows. At the same time, or later, basaltic dykes were intruded, and these, cutting through the lateritic rocks, effected marked metamorphic changes.

The Irish laterites and bauxites were formed in two distinct stages: (*a*) alteration to lithomarge, consisting of kaolinite or halloysite; and (*b*) lateritization, involving further desilication with formation of gibbsite ($Al_2O_3.3H_2O$) together with oxides of iron and titanium. With long-continued operation of the process the iron oxides tend to concentrate towards the surface, forming an increasingly ferruginous laterite and eventually a workable iron ore, overlying a layer of richly aluminous laterite or bauxite. In Ireland, unfortunately, neither complete desilication of lithomarge nor clean separation of aluminous from ferruginous laterite has occurred over more than limited areas. The prevailing types are lateritic lithomarges and ferruginous or siliceous laterites. It appears that quartz, originally present in a parental rock, may persist unchanged; the possibility of, and the conditions governing, the total elimination of quartz still require further investigation. A chemical method, devised and described by Mr. C. O. Harvey, is given for the quantitative determination of quartz in the presence of combined silica.

Much valuable information has been obtained from the application of the X-ray diffraction technique to selected specimens. The chief minerals recognized include meta-halloysite and kaolinite; gibbsite and boehmite (but not diaspore); hæmatite, goethite and magnetite; and anatase. Chamosite has been found in certain parts of the laterite horizon which exhibit a greenish tinge. Since the formation of chamosite requires reducing conditions, its occurrence implies that it is a secondary mineral relative to the lateritic minerals with which it is now associated. The abundance and distribution of various minor elements has been determined by Dr. S. Landergren, whose results demonstrate enrichment of the laterites in vanadium and probably in chromium.

Discussing the geological conditions influencing the formation of the several hydrated oxides of aluminium, Mr. Eyles points out that the widespread distribution and prevalence of the gibbsite type of bauxite suggests that this is the variety normally developed. He presents detailed evidence to justify the tentative conclusions: "(i) that the formation of monohydrates *in large amounts* results from a change of geological environment superimposed on gibbsitic laterites after the formation of the latter; (ii) that increased pressure resulting from subsidence, or dynamic action, or both, and not rise in temperature alone, may often be the main, though possibly not the sole, factor causing the *large-scale* development of monohydrates of alumina; (iii) that while igneous intrusions or lava flows alone may cause localized development of *boehmite* in laterite deposits, pressure is probably essential for the formation of *diaspore* in large quantities".

Mr. Eyles and his colleagues have made this a model investigation of its kind. It is to be hoped that their lead will be followed, so that it may no longer be necessary to direct attention to the fact that "descriptions of foreign laterite are not always sufficiently complete to permit generalizations to be drawn from the facts presented". A. HOLMES

* The Composition and Origin of the Antrim Laterites and Bauxites. By V. A. Eyles, with mineral determinations by X-ray methods by F. A. Bannister (British Museum, Natural History) and G. W. Brindley and J. Goodyear (University of Leeds). (Memoir of the Geological Survey of Northern Ireland.) Pp. vi+90. (Belfast: H.M. Stationery Office, 1952.) 12*s.* 6*d.*

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

ANNUAL REPORT FOR 1952–53

THE fifty-second annual report of the Carnegie Trust for the Universities of Scotland, covering the academic year 1952–53*, deals with a period before the most recent regulations of the Scottish Education Department for the award of bursaries by Scottish education authorities became effective so far as the Trust is concerned; but the executive committee to the trustees points out that the amounts awarded in terms of these regulations constitute a

* The Carnegie Trust for the Universities of Scotland. Fifty-second Annual Report (for the Year 1952–53). Submitted by the Executive Committee to the Trustees on 22nd February, 1954. Pp. iv+72. (Edinburgh: T. and A. Constable, Ltd., 1954.)

difficult problem for the Trust. Applications are now being received from students whose parents or guardians in the earlier years of its history would not have had recourse to the Trust, and each application presents a case in itself. Moreover, since individual education authorities frequently withdraw the bursary for a further year if the student fails to pass all his degree examinations at the appropriate time, the student often applies to the Trust for assistance towards his class fees, and the whole circumstances attendant on failure must be reviewed. While, for the time being, the executive committee has awarded class fees when there seemed to be a reasonable prospect of the student's being able to reinstate himself, it shares with the education authorities considerable anxiety as to the total effect of these bursary regulations emanating from the Education (Scotland) Act, 1946. The 1,301 students assisted during 1952–53 received £20,003 compared with £15,069 to 1,026 students during 1951–52; repayments by former beneficiaries were £2,062 from 34 beneficiaries, compared with £1,985 during 1951–52.

The amount devoted to the research scheme during 1952–53 was £32,646, or some £5,000 less than during 1951–52, and scholarship awards were made more rigorously. The special fund for assisting the publication of work embodying original research now stands at £9,059. Both the scheme recently introduced to give opportunity for senior members of university staffs to go abroad for periods of research up to one year, and the block grants to the four universities to enable members of their staff to use their vacations fruitfully in research, whether at home or on the Continent of Europe, are regarded as successful. Grants were also made to Scottish learned societies, to "A Dictionary of the Older Scottish Tongue", "The Scottish National Dictionary", "The Scottish Historical Review", and, through the universities, to "The Third Statistical Account". Appended to the report are lists of publications by fellows, scholars and recipients of grants received since September 1952, of recipients of grants and of assisted papers, and a résumé of reports upon the work of investigators under the research scheme.

In the mathematical, physical and engineering section, Sir Richard Southwell comments particularly on Dr. W. Paul's work on the effect of high pressures on the properties of semiconductors, Dr. A. G. Mackie's work on the hodograph method for the problem of compressible flow around sharp corners, and Mr. P. B. MacFarlane's study of Pleistocene changes of sea-level. In medicine, I. A. Macpherson has made marked progress in studying hæmagglutination by viruses and its inhibition by bacterial polysaccharides, and J. Grieve on the treatment of experimental peritonitis in rats with phthalylsulphathiazole.

In chemistry, Dr. T. R. R. McDonald's work on the crystal structure of ammonium bifluoride promises to yield valuable information about the nature of the hydrogen bond. Dr. A. R. M. Gibb has made excellent progress in synthesizing tropolone derivatives in his work on the preparation of compounds, structurally related to colchicine, which might possess its antimitotic effects but not its poisonous properties; Miss Evelyn E. B. Smith has discovered several new reactions involving uridine pyrophosphate derivatives, and her investigation of the enzymic mechanisms concerned has now gained her a Beit fellowship for medical research to study enzymic mechanisms at the University of Glasgow. Other investigations in chemistry noted in the advisers' report are those of W. J. Bremner on the flow of gases through a porous plug; A. J. Sorrie on the synthesis of benz*iso*tropolone, in which he has discovered the effectiveness as a condensing agent of a fused mixture of sodium chloride and aluminium chloride; R. Logan on the use of radioactive phosphorus to find the rates at which phosphorus is taken up into the different nucleotides in the constituents of the cytoplasm of the liver cells in the domestic fowl; and G. A. J. Goodlad on the enzymes found in the liver which effect transformations of sugar phosphates.

In biology, Dr. J. W. H. Lawson has commenced a lengthy investigation on the systematics and biology of aquatic species of the Chironomids, G. D. Scott is investigating the ecology and physiology of lichens, Miss Janet E. O. Towers has studied the chromosomes in amphibian oocytes, D. C. W. Smith has done much work on the endocrine control of osmoregulation in Salmonids and E. A. Salzen has made a good beginning in a study of the rate of growth of insect embryos at different stages of development.

AVERAGES OF BRIGHT SUNSHINE AND TEMPERATURE FOR GREAT BRITAIN AND NORTHERN IRELAND

THE Meteorological Office has recently published two pamphlets giving, respectively, averages of sunshine and of temperature for Great Britain and Northern Ireland during the period 1921–50*. The sunshine measurements are all made by the Campbell–Stokes instrument, which does not record sunshine below a certain level of intensity, so that the averages refer to 'bright' sunshine. The pamphlet gives average annual and monthly totals and daily means for the months and the year for 187 stations distributed all over Great Britain and Northern Ireland. The records show that, on the average, the Isle of Wight and the Sussex coast are the sunniest areas, with an annual average of more than five hours a day. This area is sunniest in summer as well as in winter. The least sunny rural areas are north and mountainous districts of Scotland, in which some stations average a little less than three hours a day. Sandown had most sunshine in the period with an annual average of 1,840 hr., but was very closely followed by Worthing, Ventnor and Eastbourne. The publication contains useful material for the study of the loss of sunshine in the centre of great cities. It is noteworthy that Bunhill Row in the City of London averaged 3·45 hr. a day against the 4 hr. of Kew and Hampstead, and Manchester (Whitworth Park) 2·9 hr. against 4·1 hr. at Hoylake and Southport. The loss of sunshine in cities is greatest, both absolutely and relatively, in winter. The publication includes a table comparing the averages for 1901–30, 1906–35 and 1921–50 at seven well-distributed stations. The mean daily sunshine at Birmingham, 3·56 hr., was the same in 1921–50 as 1901–30, but the other stations show reductions of up to 0·09 hr.

* Air Ministry: Meteorological Office. Averages of Temperature for Great Britain and Northern Ireland, 1921–50 (M.O. 571); pp. ii+36; 2*s*. Averages of Bright Sunshine for Great Britain and Northern Ireland, 1921–50 (M.O. 572); pp. ii+32; 2*s*. (London: H.M.S.O., 1953.)

The pamphlet on temperature contains monthly and annual averages of maximum, minimum and mean, half (maximum plus minimum), temperatures in degrees Fahrenheit. The lowest annual average temperature recorded, 43·5° at Braemar (1,111 ft.), is 9 deg. below the highest, 52·5° at Scilly. The mean July maximum ranges from 73·4° in London to 57·8° at Lerwick. In January Cornwall has the highest maxima, with means of 48–50°, but over most of England and Scotland mean maxima are between 42 and 45°. It is necessary to go to stations at heights of more than 500 ft. to find mean January maxima below 40° (Braemar 39·4°) or mean January minima below freezing point (Balmoral 28·4°). Comparisons between the monthly and annual averages for the periods 1901–30, 1906–35 and 1921–50 are given for seven stations. At all the stations there was an increase in mean annual temperature of about 0·5 deg. from the first to the third period. The increase, at about 1 deg., was most marked in summer. Spring and autumn also were slightly warmer; but winter was slightly colder. It is particularly interesting that the difference between the mean annual temperature of the two periods should be so uniform over the whole country.

CORPUSCULAR ECLIPSE IN THE F_2-LAYER AND ITS ASSOCIATION WITH SOLAR FLARES AND *M*-REGIONS

By Dr. PRABHAT K. SEN GUPTA
Meteorological Office, Safdarjung Airport, New Delhi
and
S. N. MITRA
Research Department, All India Radio, New Delhi

THE fact that certain intense magnetic storms tend to occur about a day after the visual observation of eruptions (flares) on the sun has led to the belief that these storms are caused by the arrival of fast beams of corpuscles (which taken as a whole are neutral) from the sun having velocities of the order of 1,000–2,000 km./sec. The most direct evidence of the presence of fast incoming particles has been provided by the observations of Meinel[1] during an intense auroral display on August 18–20, 1950. By pointing his spectrograph towards the magnetic zenith and comparing the result with that obtained with the spectrograph towards the magnetic horizon, he found that the $H\alpha$ line had a violet shift (λ 71 A. for the wing and λ 10 A. for the maximum) which corresponded to a velocity of 3,200 km./sec. for the incoming protons.

In the ionospheric regions the effect of the solar flares is manifested in the form of Dellinger type of fade-outs, which synchronize with the time of the flares, indicating that it is the ultra-violet light emitted from the solar flare which is responsible for the effect. S. N. Mitra and Mazumdar[2] found from an analysis of Delhi records for the years 1946–49 that a number of the flares were followed 20–40 hr. later by further fade-outs. For example, out of thirteen flares of type 3 and 3+, four were accompanied by simultaneous fade-outs, and in three cases, fade-outs occurred 20–40 hr. later. The other six flares were not, however, attended by simultaneous or later fade-outs. During the same period, twenty-three flares of type 2 had been reported, and they found one of these flares to be associated with simultaneous fade-out; in two cases the fade-outs were delayed by 20–40 hr. and the rest of the flares were apparently ineffective in causing fade-out.

The delayed fade-outs which are found to set in about one or two days after the visual observation of a solar flare may be attributed to the action of fast neutral beams of corpuscles originating from the flares, and speeding towards the earth with velocities of the order of 1,600–800 km./sec. Chapman[3] pointed out that if a portion of the ionization in the ionospheric layers is caused by the impact of a solar corpuscular stream, an effect should be observable during solar eclipse. He showed that a corpuscular eclipse should occur about two hours earlier than the optical eclipse if the velocity of the corpuscles is taken to be 1,600 km./sec. Later, Chapman[4] gave reasons why the ideal conditions for the corpuscular effect to be recorded are not likely to be present every time. We wish to point out that there are a number of eclipse observations on record where the investigators have directed attention to the presence of a corpuscular eclipse in accordance with Chapman's ideas: for example, those of October 1, 1940, at Queenstown by Pierce[5]; January 25, 1944, at Huancayo by Ledig *et al.*[6]; February 25, 1952, at Delhi by S. N. Mitra[7], and on the same occasion at Banaras by S. S. Banerjee *et al.*[8]. In Fig. 1, a few examples have been reproduced with the values of $f_0F_2^2$ prepared from the observations, plotted against L.M.T. A corpuscular effect is clearly seen in Figs. 1 (*b*) and 1 (*c*) about 2–2½ hr. before the optical eclipse.

Source of Corpuscular Streams

The presence of the corpuscular eclipse about two hours before the optical eclipse provides evidence that fast corpuscles are coming with velocities of the order of 1,600 km./sec.; but it does not indicate whether these corpuscles are associated with solar flares or other disturbed regions of the sun. Judging from the high percentage of magnetic storms and simultaneous radio fade-outs which do not seem to be associated with any observed flare at all, it appears that there may be some other agency on the sun which emits the corpuscles in question, for S. N. Mitra and Mazumdar[2] found that out of 122 fade-outs recorded during the years 1946–49 at Delhi, 81·2 per cent apparently had no connexion with any flare at all. This encourages us to link up the corpuscular radio fade-outs with *M*-region activity.

It is well known that some of the moderate magnetic storms which seem to have no connexion with visible solar flares have a tendency to recur every 27 days with the synodic rotation of the sun. These magnetic storms, also known as *M*-storms, have been attributed by Bartels[9] to unidentified active regions of the sun which he calls *M*-regions. The physical nature of the *M*-regions has not yet been established with certainty, nor have the *M*-regions been yet clearly associated with any prominent physical feature on the sun. Waldmeier[10] originated the idea that the intensity of the *C*-regions, that is, the coronal regions of bright line emission (particularly λ 5303), could be used as an index of the activity of *M*-regions. The analysis of Shapley and Roberts[11] for the years 1942–44 during a period of sunspot minimum indicated that the appearance of

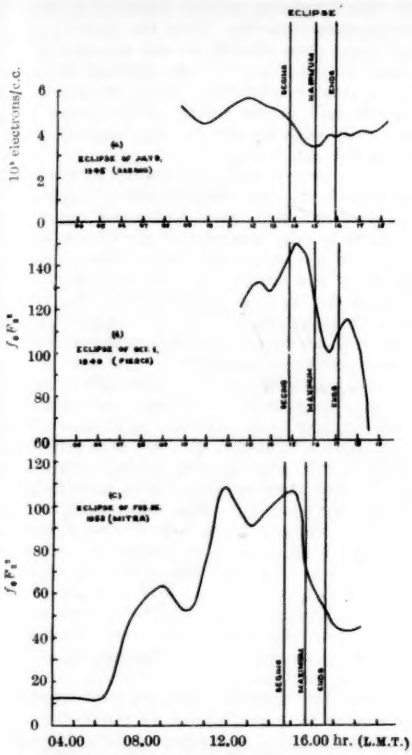


Fig. 1. Variation of the F_2-layer ion density during solar eclipses

a bright coronal patch (C-region) at the east limb of the sun was followed three to four days later by the onset of M-storms. Trotter and Roberts[12] and Müller[13] confirmed the ideas of Shapley and Roberts from the records of 1952 (which is close to the next period of sunspot minimum) and also estimated the lag to be about three days. Allen[14] has associated the onset of M-storms with the central meridian passage of coronal streamers, and is of the opinion that the corpuscles responsible for the M-storms take about one day for intense storms and longer for moderate storms to reach the earth. Von Klüber[15] supported Allen's views from his observation of the solar corona during the total solar eclipse on February 25, 1952, at Khartoum, when a long and intense streamer was seen at the east limb of the sun. Waldmeier[16] suggested from a scrutiny of the 1939–40 observations that the M-storms occurred about one day after the central meridian passage of the bright coronal patches. Later he[16] expressed the view that the bright coronal regions were only partly responsible for M-region activity, which he believed on further consideration to originate in the neighbourhood of large sunspot groups after the disappearance of the spots. He also directed attention to the fact that as long as new spot groups did not appear, the areas vacated by spots were associated with stationary prominences and coronal streamers. Maxwell[17] cited an example when M-region activity developed 27 days after an intense radio emission, which was associated with a decaying sunspot group.

The lesson of these observations appears to be that the mystery of the M-regions on the sun is still unsolved. But they bring out clearly the inference that the M-storms develop as a result of a corpuscular effect, the corpuscles taking, according to different views, about one to three days to reach the earth. (Wulf and Nicholson[18] have, however, suggested that the M-storms are caused by intense ultra-violet light from areas of bright calcium and hydrogen flocculi when appearing at the east limb of the sun.) The corresponding velocities would be of the order of 1,600–600 km./sec. The strength of the storm would obviously be governed by the speed and intensity of the corpuscular stream.

The moderate M-storms have been known to persist for months through several rotations of the sun, indicating apparently that the slower corpuscles with velocities of 800–600 km./sec. are predominantly emitted by the M-regions. These slower particle streams, if they exist, should give rise to a similar corpuscular eclipse in the variation of f_0F_2 about four to six hours earlier than the corresponding optical eclipse, provided such particles are able to penetrate the F_2-layer. Fortunately, the analysis of a number of ionospheric data secured by different observers at widely different stations, and quite independent of each other, confirms this view. A glance at Figs. 1 (*a*) and 1 (*c*) quoted above shows that at about 5 hr. before the time of maximum of optical eclipse there was a significant drop in the curves, which could be interpreted as a corpuscular eclipse due to corpuscles having velocity of the order of 640 km./sec. Smith-Rose[19] has also reported that the observations carried out near Moscow during the eclipse of July 9, 1945, indicated the presence of a corpuscular eclipse corresponding to velocities of the order of 450–600 km./sec. Only a few cases were available for which the expected time of occurrence of corpuscular eclipse happened to lie within the daylight hours. It was also found that in a good many cases the observations had not been extended to cover the period when a corpuscular eclipse could be detected; such an effect at about five to six hours before the time of optical eclipse was not expected. But the records of Harang[20] (Fig. 1*a*), S. N. Mitra[7] (Fig. 1*c*) and the report of Smith-Rose provide positive evidence that the slower corpuscles responsible for the effect take about three days to travel from the sun to the earth.

A feature of considerable interest is brought out in the observations of S. N. Mitra[7] (Fig. 1*c*), which shows the presence of two corpuscular eclipses, at about 2½ hr. and 5 hr. respectively before the time of maximum of the optical eclipse on February 25, 1952. This result indicates that there were two predominating groups of corpuscles on that occasion, one of which had a velocity of about 1,300 km./sec. and started one day earlier on the sun, and the other group a velocity of about 640 km./sec. and started about 2½ days earlier on the sun. S. S. Banerjee *et al.*[8] obtained the effect due to a corpuscular eclipse at about 2½ hr. earlier than the optical eclipse on the same occasion at Banaras; his records do not extend sufficiently to show the other corpuscular eclipse. It may be mentioned in this connexion that according to the observations of the Solar Observatory, Kodaikanal, there were no solar flares during February 1952, and therefore neither of the corpuscular eclipses could be associated with any flare activity. But marked magnetic and ionospheric disturbances prevailed on February 23, 24 and 25, 1952, no doubt under the influence of corpuscular streams associated with M-regions.

It may be noted that some of the velocities given above are less than the critical velocity of 616 km./sec. required for escape of a particle from the sun's surface (for example, 600 km./sec. required for a three-hour delay); but the reason may be that particles emitted with such velocities may describe very elongated ellipses, which may carry them beyond the neutral point of gravitational attraction between the sun and the earth and thus may enable them to enter the earth's domain. For a velocity slightly smaller than the critical velocity, the path may be widely different from a straight one, and thus it may be greater than the actual sun–earth distance. This may cause considerable reduction of the velocity. In conclusion, the suggestion is made that in future eclipse expeditions the observation of the F_3-layer of the ionosphere should be started at least seven hours earlier than the moment of totality.

Our thanks are due to Prof. M. N. Saha for his interest. [Jan. 4.

[1] Meinel, A. B., *Science*, **112**, 590 (1950).
[2] Mitra, S. N., and Mazumdar, S. C., "Effect of Solar Activity on Ionosphere and Earth's Magnetic Field", Indian Science Congress, January 1951.
[3] See Chapman and Bartels, "Geomagnetism", p. 818 (Oxford, 1940).
[4] Chapman, S., *J. Geophys. Res.*, **55**, 361 (1950).
[5] Pierce, J. A., *Proc. Inst. Radio Eng.*, **36**, 8 (1948).
[6] Ledig, P. G., Jones, M. W., Giesecke, A. A., and Chernosky, E. J., *Terr. Mag. Atm. Elec.*, **51**, 411 (1946).
[7] Mitra, S. N., *J. Sci. Indust. Res., India*, **12** A, 319 (1953).
[8] Banerjee, S. S., Rajan, V. D., and Banerjee, P. C., *J. Sci. Indust. Res., India*, **11** B, 197 (1952).
[9] Bartels, J., *Terr. Mag. Atm. Elec.*, **37**, 1 (1932); **39**, 201 (1934).
[10] Waldmeier, M., *Z. f. Astrophys.*, **19**, 21 (1939): **21**, 275 (1942).
[11] Shapley, A. H., and Roberts, W. O., *Astrophys. J.*, **103**, 257 (1946).
[12] Trotter, D. E., and Roberts, W. O., Report HAO–NBS 10, High Altitude Observatory, Colorado, U.S., 1952.
[13] Müller, R., *Observatory*, **73**, 75 (1953).
[14] Allen, C. W., *Mon. Not. Roy. Astro. Soc.*, **104**, 13 (1944).
[15] Von Klüber, H., *Observatory*, **72**, 207 (1952).
[16] Waldmeier, M., *Terr. Mag. Atm. Elec.*, **51**, 537 (1946).
[17] Maxwell, A., *Observatory*, **72**, 22 (1952).
[18] Wulf, O. R., and Nicholson, S. B., *Pub. Astro. Soc. Pacific* **60**, 37 (1948).
[19] Smith-Rose, R. L., *Nature*, **153**, 40 (1946).
[20] Harang, L., *Terr. Mag. Atm. Elec.*, **50**, 307 (1945).

VASCULAR PLANTS COMMON TO THE ARCTIC AND THE BRITISH ISLES

By Dr. NICHOLAS POLUNIN
Gray Herbarium, Harvard University, Cambridge, Mass.

SOME fourteen years ago I published[1,2] an attempted analysis of "Arctic Plants in the British Isles", which was based on one hand on the existing, but partly outdated, British floras and, on the other, on such vascular plants as were known to occur north of lat. 75° N. Sixty-two species or geographical varieties (subspecies) in the native British flora as then known were recognized as being undoubtedly arctic in their affinities, in the absence of proper criteria for a more adequate computation. Of these, no less than forty were characteristic of open soil or rock crevices, seven more were plants of sea-shores or lake margins (making a total of forty-seven characteristic of open habitats), a further eight were characteristic of other habitats but frequently found in open areas in both regions (making a total of fifty-five which are to be found in open habitats), and only the remaining seven of the sixty-two were marsh or 'heath' plants usually confined to these or other closed communities. Thus the great majority (75·8 per cent) grew chiefly in the absence of competition and no less than 88·7 per cent are frequently found in at least ecologically 'open' situations both in the north and in the south, while some of the remainder may occasionally be encountered in such habitats in the Arctic.

Apart from more floristic exploration in the British Isles and the Arctic, in both of which a great deal has been accomplished since 1939, the main needs before a more worthy analysis of the situation could be made were (1) a proper or at least 'working' delimitation of the Arctic, (2) a modern flora of the Arctic based on such a delimitation, and (3) an up-to-date British flora. With (1) I have long been concerned and, although far from satisfied with the result, have latterly ventured to publish my suggestions (by special request, "although suspecting that in time increased knowledge of local flora, precipitation, total heat, and the incidence of frosts as well as the combination of wind and cold known as 'windchill' will add solidity to the picture, and knowing full well that increased local knowledge will add to its precision"[3]). The accompanying map indicates the southern boundary of the Arctic and proposed subdivision of the latter for phytogeographical citation into ten sectors (the longitudinal subdivision into low-, middle-, and high-arctic zones cannot yet be indicated). At (2) I have been working off and on since 1940, with the result that I now have virtually completed a "Circumpolar Arctic Flora" (to be published by the Oxford University Press) of all the families, genera and species of vascular plants that are known to reach the Arctic as delimited in (1): a proper critical treatment involving lower taxa will have to await the availability of far more Siberian material than is at present open to the Western world. Prerequisite (3) has recently been covered by the publication of Clapham, Tutin and Warburg's welcome "Flora of the British Isles"[4], to which should already be added further pertinent species[5]. Consequently, a far more adequately based analysis of the species of vascular plants common to the Arctic and the British Isles can now be made.

Taking in general a rather broad, 'conservative' view of specific limits, I have computed that 874 species of vascular plants are so far known to inhabit the Arctic (according to my largely *ad hoc* delimitation). Of these, 833 are native and 41 appear to be established aliens. Of the latter, 33 occur as natives in the British Isles according to the latest reckoning[5], as does probably another not recognized therein, 6 more occur in the British Isles as aliens, while at least 3 native arctic species seem to be well-established introductions in Britain. There appears to be only a single recognized arctic alien that is unknown in Britain in anything approaching a wild state, though probably others will be recognized when the northern parts of Siberia, particularly, become better known to Western botanists.

Of the 833 species of native arctic vascular plants at present recognized, no less than 267 occur in the native British flora, in which they consequently form a very substantial 'element' and, in addition, two more used to occur but are now apparently extinct. To arrive at the main figure, occasional compressions have had to be made to get over differences of opinion as to specific limits, especially where insufficient herbarium material was available for practical

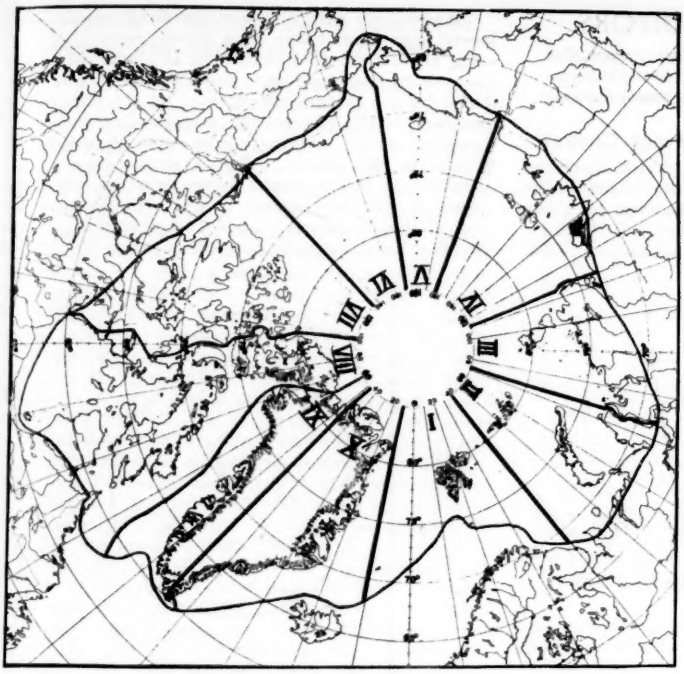


Fig. 1. North polar regions, showing proposed delimitation and subdivision of the Arctic

clarification; the result when we add introduced plants is that 309, or more than 35 per cent, of the species of vascular plants so far known to inhabit the Arctic occur also in the British Isles. This excludes supposedly extinct species but includes aliens; even if the latter, too, are excluded, just over 32 per cent of native arctic vascular species are known in the present-day native British flora. Of the remainder, stimulated by news of several recent discoveries, I have selected the fifty which seem to me most likely to be found in the British Isles in the future[4]. The majority of these are plants of open soil or other habitats where there is little or no competition with other species, and almost all are able to grow in such situations in the Arctic.

It remains to make an analysis, primarily along the lines attempted previously from much less adequate data[2], of the 309 species of vascular plants at present accepted as common to the Arctic and the British Isles. Representing introduced species are all those supposedly transported by man to the regions concerned—whether by the Norsemen many centuries ago or by others quite recently—so long as they appear to have become established in a more or less wild state, and whether introduced to the Arctic or Britain or both. In cases of serious doubt, as, for example, where a normally introduced species could, so far as the habitat or collection-label indicated (or failed to indicate), be considered as perhaps locally native, it has been counted as introduced, so as not to weigh unfairly on the side of the natives. But when a normally introduced species appears to be native in even one place in the Arctic it has been counted as native therein.

The following categories and representations were recognized in this new analysis.

(1) Plants commonly of open soil or rocky, etc., habitats with little or no competition (although humus may be plentiful). (*a*) Found in all three latitudinal arctic zones and of wide distribution meridionally in the Arctic (occurring in at least 5 of the 10 sectors indicated in the map). Total 47 (all native). (*b*) Occurring northward at least to the middle-arctic zone and found in at least 3 sectors (cf. map). Total 23 (all native). (*c*) Limited to the low-arctic zone or otherwise of restricted distribution in the Arctic. Total 59 (including 25 introductions, namely, 19 introduced in the Arctic, 1 in Britain, and 5 in both).

(2) Plants of sea-shores or lake, etc., margins (including aquatics) with little or no competition. Total 43 (all native).

(3) Plants to be found in open areas but characteristic of closed habitats. Total 89 (including 15 introductions, namely, 13 introduced in the Arctic, 1 in Britain, and 1 in both).

(4) Plants usually restricted to closed habitats. Total 48 (including 2 introductions, namely, 1 introduced in Britain and 1 in the Arctic).

It is thus seen that, of the species of vascular plants common to the Arctic and the British Isles, a total of 172 or 55·66 per cent are to at least a considerable extent 'open soil' plants or their competition-ecology equivalents, and a further 89 (making a total of 84·46 per cent) are fairly frequently to be found growing in such circumstances. Although these percentages are lower than those formerly computed from a much more limited flora[2]—as was to be expected particularly in view of the preponderance of open habitats in the Far North—the latter one is only slightly lower. This confirms the earlier suggestion that the majority of British vascular plants which reach high latitudes grow largely where there is little or no competition, while the vast majority of them are fairly frequently to be found in such circumstances—in the south where closed vegetation is the general rule as well as in the Arctic where it is not. Even of the 48 remaining species normally restricted to heathy, marshy, or other closed habitats, a considerable proportion are occasionally to be seen growing in 'open' areas.

Further notes and details will shortly be published in *Watsonia*—including, in line with the policy followed on the previous occasion, lists of the species of plants in each of the above categories.

[1] "The Arctic Element in the British Flora" (abstract), *Proc. Linn. Soc. London*, Session 151, 131 (1939).
[2] *Nature*, **144**, 352 (1939); *J. Bot.*, **77**, 270 (1939).
[3] *J. Ecol.*, **39**, 308 (1951).
[4] "Flora of the British Isles" (Cambridge University Press, 1952).
[5] *Nature*, **168**, 934 (1951); **171**, 335 (1953).
[6] *Watsonia*, **3**, 34 (1953).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Radio Emission from the Perseus Cluster

A RADIO source the position of which coincides closely with the cluster of extragalactic nebulæ in the constellation of Perseus has been observed by Ryle, Smith and Elsmore[1], by Mills[2] and by Hanbury Brown and Hazard[3]. The last-named authors have suggested that the observed radio emission is to be associated with the cluster as a whole, and they have pointed out that on this hypothesis there is an important discrepancy between the average radio emission of the individual galaxies of the cluster and that of nearby galaxies. Baade and Minkowski[4], on the other hand, have suggested that the radio source should be identified with *NGC* 1275, one of the members of the cluster. This nebula, like that associated with the intense radio source in Cygnus, is probably another example of two galaxies in collision; the optical spectrum contains lines of high excitation and the structure suggests that a collision has taken place between an elliptical and a spiral nebula.

Experiments to decide which of these two hypotheses is correct are important since they might provide information concerning the radio emission accompanying a collision of this type; alternatively, if the radiation were found to originate in the cluster as a whole, it would have importance in connexion with the relation between the visual and radio magnitudes of extragalactic nebulæ.

The angular diameter of the whole visible cluster is approximately 2°, whereas that of *NGC* 1275 is only 0·7′. Measurements of the angular diameter of the radio source should therefore be important in distinguishing between the two possible interpretations. If the source proved to have small angular size, its association with *NGC* 1275 might be confirmed by accurate positional measurements.

Observations with the new Cambridge radio telescope[5] have been made on a wave-length of 3·7 m. using interferometer apertures of 14 λ and 157 λ. On the assumption that the radio emission was produced by the integrated effect of all the component members of the cluster, the angular distribution of intensity was calculated from optical counts of nebulæ in the cluster. For a source having this distribution, the apparent intensity which would be observed with an aperture of 157 λ would be 7 per cent of that obtained with a 14 λ aperture. If, on the other hand, the radiation originated in *NGC* 1275, the intensities observed with the two apertures would be the same to within ½ per cent. The results obtained are summarized as follows:

Aerial spacing	Apparent intensity
14 λ	16×10^{-25} W.m.$^{-2}$ (c./s.)$^{-1}$
157 λ	12×10^{-25} W.m.$^{-2}$ (c./s.)$^{-1}$

These results show that about 75 per cent of the radiation originates in a source of small angular size; the close agreement between the position obtained with the high resolving power and that of *NGC* 1275 shown in the figure provides strong confirmation of the identification made by Baade and Minkowski.

The intensity produced by the remaining galaxies of the cluster is approximately 4×10^{-25} W.m.$^{-2}$ (c./s.)$^{-1}$; this is in good agreement with that derived on the assumption that there is a constant ratio between the optical and radio emission of extragalactic nebulæ.

These observations were undertaken as part of a programme of research supported in the Cavendish Laboratory by the Department of Scientific and Industrial Research, to which one of us (J. E. B.) is indebted for a maintenance allowance.

J. E. Baldwin
B. Elsmore

Cavendish Laboratory,
Cambridge. March 6.

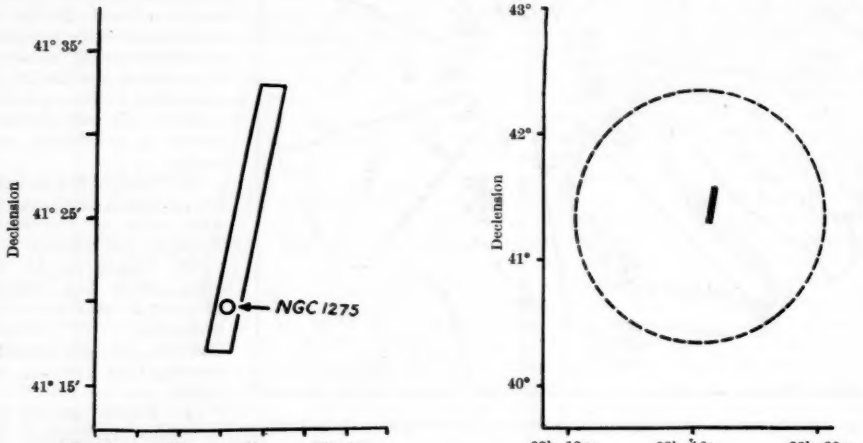


Figure showing the position and limits of error of the radio source obtained with the 157 λ aperture in relation to (*a*) *NGC* 1275 and (*b*) the Perseus cluster as a whole. (Epoch 1950.0)

[1] Ryle, M., Smith, F. G., and Elsmore, B., *Mon. Not. Roy. Astro. Soc.*, **110**, 508 (1950).
[2] Mills, B. Y., *Aust. J. Sci. Res.*, A, **5**, 266 (1952).
[3] Brown, R. Hanbury, and Hazard, C., *Phil. Mag.*, **43**, 137 (1952).
[4] Baade, W., and Minkowski, R., *Astrophys. J.* (in the press).
[5] Ryle, M., and Hewish, A. (in preparation).

Intensities of Discrete Radio Sources in Cygnus and Cassiopeia at 22·6 Mc./s.

It is important both for the understanding of the nature of the localized radio sources and the determination of interstellar radio absorption to extend the measurement of the spectra of the sources to as low radio-frequencies as possible. Ionospheric transmission sets a limit, but by choosing frequencies not too close to the critical frequency, and restricting observations to days of low ionospheric disturbance, reasonably accurate measurements may be obtained. In this way, we have recently made measurements at a frequency of 22·6 Mc./s. ($\lambda = 13{\cdot}3$ m.) by means of an interferometer consisting of two aerials spaced in the east–west direction at 20 wave-lengths apart, thus producing lobes in the aerial pattern at intervals of about 3°. Each aerial consists of an array of six full-wave dipoles giving a vertically directed beam of width $\pm$ 22° and $\pm$ 9° in the north–south and east–west directions respectively. The recording apparatus is a simplified form of the type described by Machin, Ryle and Vonberg[1], whereby the receiver is continually switched to a standard noise diode source which is automatically adjusted by a servo-mechanism to equalize the received radiation.

Recordings of the intensity of the discrete radio sources in Cygnus and Cassiopeia were made between June and November 1953. Ionospheric conditions frequently caused violent amplitude fluctuations, and at times there were not only severe decreases of intensity but also increases from the undisturbed value by a factor of two or three. In determining the absolute intensity of the sources, only those records were used where the fluctuations were of negligible amplitude, and this occurred on more than thirty days during the period of observation. The absolute intensities of Cassiopeia and Cygnus were respectively $9{\cdot}4 \times 10^{-22}$ and $4{\cdot}6 \times 10^{-22}$ watts m.$^{-2}$ (c./s.)$^{-1}$ with an r.m.s. error of less than 20 per cent, excluding a possible systematic error in aerial gain. If the sizes of the sources are taken to be those determined by Hanbury Brown, Jennison and Das Gupta[2,3] at 125 Mc./s., the brightness temperature of Cassiopeia at 22·6 Mc./s. is about 6×10^8 deg. K. and that of Cygnus about 3×10^9 deg. K.; it is possible that the sources may be more extensive at the lower frequency and the brightness temperature correspondingly reduced.

The values we have obtained at 22·6 Mc./s. have been plotted in Fig. 1, together with the intensities at higher frequencies published by Stanley and Slee[4], Ryle, Smith and Elsmore[5], Hanbury Brown and Hazard[6], and Mills[7], and the results indicate that the intensity continues to increase as the frequency is decreased. The spectrum of Cassiopeia follows a law of intensity proportional to (frequency)$^{-1{\cdot}2}$. The spectrum of Cygnus, on the other hand, closely follows the same law as Cassiopeia at higher frequencies but, at low frequency, appears to deviate by about 20 per cent. The accuracy of the measurements of absolute intensity are probably only of this order, but the reality of this deviation can be tested by comparing the more accurate relative values of the intensities of the two sources obtained by those observers who, on their particular frequency of observation, have used their apparatus to measure both sources. These ratios are shown in Table 1, which again indicates that, although at the higher frequencies the ratios of the intensities of Cygnus and Cassiopeia are equal, at the lowest frequency

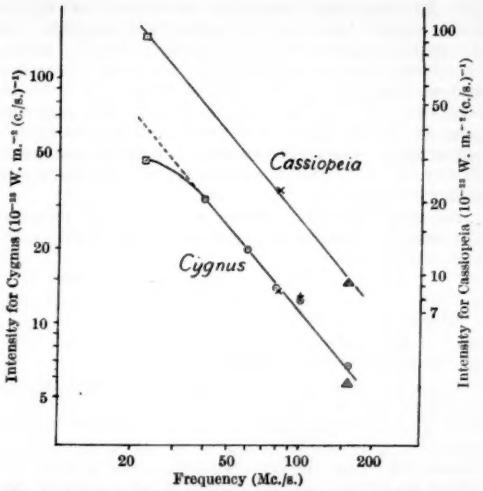


Fig. 1. Spectra of the discrete sources in Cygnus and Cassiopeia. The straight lines represent the law of intensity $\propto$ (frequency)$^{-1{\cdot}2}$. ○, Stanley and Slee (ref. 4) (intensities tabulated by Piddington and Minnett, ref. 13, are plotted); ×, Ryle, Smith and Elsmore (ref. 5); △, Hanbury Brown and Hazard (ref. 6); +, Mills (ref. 7); ⊡, present results

the intensity of Cygnus is reduced by about 20 per cent in comparison with Cassiopeia.

Baade and Minkowski[8] have recently associated the source in Cassiopeia with unusual nebulous filaments of gas at a range not greater than 500 parsecs; the source in Cygnus appears to be due to the collision of two nebulæ and is at a range of 34 megaparsecs on the old distance scale. The source in Cassiopeia is a member of the galactic system, and although close to the galactic equator, it is a near source which shows no evidence of visual obscuration. The Cygnus source is extra-galactic and situated at low galactic latitude near the edge of the 'zone of avoidance'[9], the region in which the numbers of observed extra-galactic nebulæ are reduced by visual obscuration. Observations of the 21-cm. line emission[10,11] also indicate the occurrence of a considerable depth of hydrogen in the ground-state in this direction. If the interstellar gas is appreciably ionized, absorption may be expected at the lower frequencies. As the high-frequency spectra of the two radio sources are similar, and both seem to have their origin in low-density clouds with high internal velocities, it is possible that their emission spectra may be fundamentally the same but that the intensity of Cygnus at 22·6 Mc./s. is reduced by interstellar absorption. Alternatively, part of, or all, the reduction may be characteristic of the spectrum at the source. As it appears unlikely that the slope of the frequency spectrum would increase in magnitude,

Table 1. Intensities of the Radio Sources in Cygnus and Cassiopeia

Observer	Frequency (Mc./s.)	Intensity in units of 10^{-22} watts m.$^{-2}$ (c./s.)$^{-1}$		Ratio of Cygnus/Cassiopeia
		Cassiopeia	Cygnus	
Hanbury Brown and Hazard (ref. 6)	158·5	9·25	5·7	0·62
Ryle, Smith and Elsmore (ref. 5)	81·5	22·0	13·5	0·61
Present results	22·6	94	46	0·49

the 20 per cent intensity reduction of Cygnus is an upper limit to the galactic absorption. The integrated product of path-length times absorption coefficient is consequently not more than 0·2; and as the galactic latitude of Cygnus is 4·9°, the comparatively low absorption is a further confirmation of the findings of Scheuer and Ryle[12] that, if appreciable ionized interstellar gas is present in the galaxy, it is confined within narrow limits to the galactic equator.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

J. S. Hey
V. A. Hughes

Radar Research Establishment
(Ministry of Supply),
Malvern, Worcs. March 1.

[1] Machin, K. E., Ryle, M., and Vonberg, D. D., *Proc. Inst. Elect. Eng.*, **99**, Pt. III, 127 (1952).
[2] Brown, R. Hanbury, Jennison, R. C., and Das Gupta, M. K., *Nature*, **170**, 1061 (1952).
[3] Jennison, R. C., and Das Gupta, M. K., *Nature*, **172**, 996 (1953).
[4] Stanley, G. J., and Slee, D. B., *Aust. J. Sci. Res.*, A, **3**, 234 (1950).
[5] Ryle, M., Smith, F. G., and Elsmore, B., *Mon. Not. Roy. Astro. Soc.*, **110**, 508 (1950).
[6] Brown, R. Hanbury, and Hazard, C., *Mon. Not. Roy. Astro. Soc.*, **113**, 123 (1953).
[7] Mills, B. Y., *Aust. J. Sci. Res.*, A, **5**, 266 (1952).
[8] *Observatory*, **73**, 188 (1953).
[9] Hubble, E., *Astrophys. J.*, **79**, 8 (1934).
[10] Muller, C. A., and Oort, J. H., *Nature*, **168**, 357 (1951).
[11] Christiansen, W. N., and Hindman, J. V., *Aust. J. Sci. Res.*, A, **5**, 437 (1952).
[12] Scheuer, P. A. G., and Ryle, M., *Mon. Not. Roy. Astro. Soc.*, **113**, 3 (1953).
[13] Piddington, J. H., and Minnett, H. C., *Aust. J. Sci. Res.*, A, **5**, 17 (1952).

Temperature Distribution in an Electrically Heated Filament

The distribution of temperature in a filament electrically heated *in vacuo* has been studied by several previous authors. The differential equation defining the steady state is:

$$\frac{d^2T}{dx^2} + \frac{5}{2}\,a\,(T_m^4 - T^4) = 0, \qquad (1)$$

in which T is the temperature at a distance x from one of the ends, T_m is the value to which the temperature T_l at the centre tends as the length $2l$ of the filament is increased indefinitely, keeping the heating current the same, and a is a constant determined by the cross-section of the filament, its thermal conductivity and the emissivity of its surface. Using the boundary conditions $T = \Theta$ when $x = 0$, and $dT/dx = 0$ when $x = l$, one obtains[1]

$$x = \int_{\Theta}^{T} [5aT_m^4\,(T_l - T) - a\,(T_l^5 - T^5)]^{-\frac{1}{2}}\,dT, \qquad (2)$$

the value of T_l occurring in (1) being determined by the condition that, when the upper limit of the integral is made equal to T_l, x should become l.

In a recent paper[2] it was shown that though the integral cannot be evaluated directly, it can be expanded as a convergent power series. The filament can be divided for this purpose into two distinct regions, region A comprising a certain length near the middle, and region B outside it, the power series referred to being different in the two regions.

Now, denoting $T_m - T$ by Δ, it can be shown that:

$$\Delta \exp f(\Delta) = \exp \pm x\sqrt{A} \qquad (3)$$

are solutions of (1), where

$$A = 10\,a\,T_m^3 \qquad (4)$$

and

$$f(\Delta) = \frac{1}{2}\frac{\Delta}{T_m} + \frac{1}{16}\frac{\Delta^2}{T_m^2} - \frac{1}{240}\frac{\Delta^3}{T_m^3} - \cdots \qquad (5)$$

The effect of the finite temperature coefficient of the thermal conductivity, and of the other constants, can also be taken into account by replacing the factors $\frac{1}{2}$, $\frac{1}{16}$, $-\frac{1}{240}$, ... by A_1, A_2, A_3, ... which can be calculated. For a tungsten filament with $T_m = 2{,}400°$ K., $A_1 = 0{\cdot}75$, and the other A's are much smaller.

In the region where $\exp f(\Delta)$ is close to unity, a general solution for the finite filament can be obtained by suitably combining the two particular solutions given by (3). The corresponding two terms in the general solution are obviously such that one of them increases rapidly and the other decreases rapidly as we move away from the centre of the filament. If $T_m - T_l$ is sufficiently small, the latter term may become negligible in comparison with the former, while Δ still remains small enough to permit our combining the two particular solutions. When this has happened, the need to keep $\exp f(\Delta)$ close to unity disappears. We thus obtain a *practical* general solution that is applicable over the whole length of the filament, namely:

$$\begin{aligned}&\Delta \exp f(\Delta)\\ &= \Delta_0 \exp f(\Delta_0)\,[\exp - x\sqrt{A} + \exp\{-(2l - x)\sqrt{A}\}]\\ &= \Delta_0 \exp f(\Delta_0) \exp - l\sqrt{A}\,(\exp q\sqrt{A} + \exp - q\sqrt{A}),\end{aligned} \qquad (6)$$

where $\Delta_0 = T_m - \Theta$, and $q = l - x$ is the distance measured from the centre.

Now for a filament for which $T_m - T_l$ is small in comparison with T_m, which we shall refer to for convenience as a 'long' filament, the limit of the A-region is given by $\Delta_c \sim 3(T_m - T_l)$. At this point it is found that the ratio of the second term inside the brackets in (6) to the first term has decreased to about $\exp(-3{\cdot}6)$, that is, below 3 per cent. Taking for convenience this fraction, namely 0·03, as small in comparison with unity, we can readily investigate how small $T_m - T_l$ should be in comparison with T_m in order that (6) may hold over the whole length of the filament to at least this degree of accuracy.

It may appear at first sight that the criterion for our being able to combine the two particular solutions, namely, that $\exp f(\Delta)$ should be close to unity, will become increasingly difficult to satisfy as Δ increases. But actually, owing to the disparity in the magnitudes of the two terms to be combined, which increases rapidly as one moves away from the centre, the working criterion becomes $f(T_m - T_l) < 0{\cdot}03$, or $(T_m - T_l) < 0{\cdot}04T_m$. When this is secured, (6) will fit with observation to a much closer accuracy than 3 per cent, the accuracy increasing rapidly as one moves away from the centre of the filament.

The results obtained earlier for such a filament, on the basis of the series-expansion of the integral—namely, the parabolic variation of temperature in the A-region, the closeness of the distribution outside the A-region to that of a similar infinitely long filament heated by the same current and the logarithmic distribution at the top of this range—all come out as special cases of (6).

By putting $x = l$ in (6), one obtains a useful relation for the temperature T_l at the centre of a long filament, as a function of its length, namely:

$$T_l = T_m - 2\Delta_0 \exp f(\Delta_0) \times \exp -l\sqrt{A}, \quad (7)$$

in view of which (6) may also be written in the convenient form,

$$\Delta \exp f(\Delta) = \tfrac{1}{2}(T_m - T_l)(\exp q\sqrt{A} + \exp -q\sqrt{A}), \quad (8)$$

which is applicable over the whole length of a long filament.

K. S. Krishnan
S. C. Jain
National Physical Laboratory of India,
Hillside Road,
New Delhi 12.
Feb. 12.

[1] See Carslaw, H. S., and Jaeger, J. C., "Conduction of Heat in Solids", 135 (Oxford: Clarendon Press, 1947).
[2] Krishnan, Sir K. S., and Jain, S. C., *Nature*, 173, 166 (1954); *Proc. Roy. Soc.*, A (in course of publication).

A New Technique for investigating Surface Flow in Metal-working Processes

During the plastic deformation of metals in shaping processes, there is relative movement between the flowing metal and the tools. An attempt was made by Siebel and Osenberg[1] to deduce this relative movement by noting the distortion of a grid scribed on the surface of strip before further rolling. The accuracy was not high, however, and the method yielded little information on surface flow.

It occurred to us that small projections on the surface of the rolls or tool faces might give rise to ploughed tracks on the surface of the metal undergoing deformation, and that such markings might provide illuminating evidence regarding the relative movement. We have observed that tracks or surface scratches are, in fact, produced by the adventitious minute projections normally present on rolls and platens. These surface scratches provide a valuable means of investigating the topography of surface flow during deformation.

When a metal strip is reduced in thickness by passing it between cylindrical rolls, its speed, on entering the zone of deformation, is less than that of the roll periphery. The strip is accelerated until, at some 'neutral position' within the region of contact, roll and strip surfaces are moving with the same velocity, and the strip finally emerges moving more rapidly than the rolls. The relative movement which takes place generates the surface scratches mentioned above. Spreading in the lateral direction adds a second component of relative velocity at right angles to the first, and a curved scratch is produced. The final shape is like that of a fish-hook. Fig. 1 shows stages in the development of scratches through the arc of contact. The specimen was prepared by interrupting the rolling process and removing the strip for examination.

A preliminary investigation based on the measurement of surface scratches has led to several conclusions regarding the rolling process.

(1) The projected length of scratch in the rolling direction is close to the length predicted by a simple theory based on the assumption that the deformation is homogeneous.

(2) The neutral position, which is related to the frictional conditions in rolling, can be directly observed.

(3) The spread of elements in the surface can be measured by observation of the length of the scratch projected in the lateral direction.

(4) Since the direction of the growing end of a scratch within the region of contact coincides with the direction of the frictional force at that point, maps of frictional force direction in the region of contact may be constructed. In theories of rolling it has always been assumed that the frictional forces are parallel to the rolling direction. Observations have shown that even with small lateral spread (less than 1 per cent) this is far from being the case.

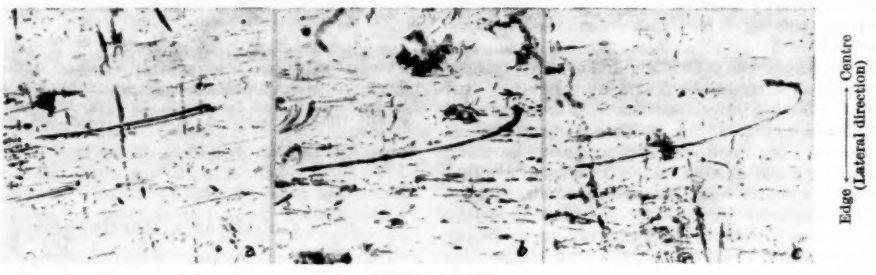


Fig. 1. Surface scratches on partly rolled copper strip (2 in. wide × 0·2 in. thick: reduction, 15 per cent). (*a*) Between entry and neutral position; (*b*) near neutral position; (*c*) at exit. × 150

Further work using the technique described here is in progress.

J. M. Capus
M. G. Cockcroft
Department of Industrial Metallurgy,
University of Birmingham.
Feb. 3.

[1] Siebel, E., and Osenberg, E., *Mitt. K.-W.-Inst. f. Eisenforschung*, 16, 33 (1934).

Refractive Index of Concentrated Protein Solutions

An accurate knowledge of the specific refraction increment α, or dn/dC, of proteins is important in measurements which involve the use of the ultracentrifuge, electrophoresis and light-scattering. Recently, it has become important in connexion with cytological methods of refractometry[1] and mass determination[2] of living cells. The refraction increment has hitherto usually been measured only at rather low concentrations. The highest concentration reported seems to be by Howard[3] in 1920, who found that the variation of refractive index with concentration of hæmoglobin was linear up to about 17 per

cent. Armstrong *et al.*[4] found that α for crystalline serum albumin was constant up to a concentration of 14·6 per cent. Since in cytology considerably higher concentrations may be encountered, and it is well known that the refractive indices of some substances, for example sugars, do not vary quite linearly with concentration, we have measured the refractive indices of bovine serum albumin solutions up to concentrations exceeding 50 per cent. In order to avoid the difficulties associated with the measurement of protein concentrations by dry-weight or nitrogen determinations, we have obtained a factor proportional to the concentration by measuring the optical density at 278 mμ, using a Hilger 'Uvispek' ultra-violet spectrophotometer. Deviations from the Beer–Lambert law were avoided by diluting all samples accurately by different amounts to give approximately the same final optical density. The final concentration was about 0·2 per cent in each case, giving optical densities between 1·0 and 1·3 for a 1-cm. path-length.

Fig. 1 shows the results obtained with non-crystalline bovine serum albumin fraction V (Armour) dissolved in distilled water. Refractive indices were measured at 20° C. in an Abbe type refractometer at λ 5780 A. Optical density values were converted to protein concentration by using the published figure[5] of 6·6 for $E(1\%, 1\text{ cm.})$. The probable errors increase with concentration because of the difficulty in manipulating and measuring very viscous solutions. Nevertheless, the refractive index increases linearly with concentration up to at least 45 per cent. The value of α obtained was 0·00182. This is in reasonably good agreement with values found by others[4,6]; but in view of possible uncertainties in the extinction coefficient and hence in the protein concentrations, no claims for high accuracy are made. The main purpose of this investigation was to determine whether α remained constant with increasing concentration.

Excellent linearity has also been obtained in the case of peptone (Evans bacteriological) up to 50 per cent concentration. The value for α in this case was 0·00174, but this was based on the weight of peptone as supplied. Since the moisture content of this product is approximately 5 per cent, the corrected value for α would be 0·00183, again in good agreement with values obtained for proteins.

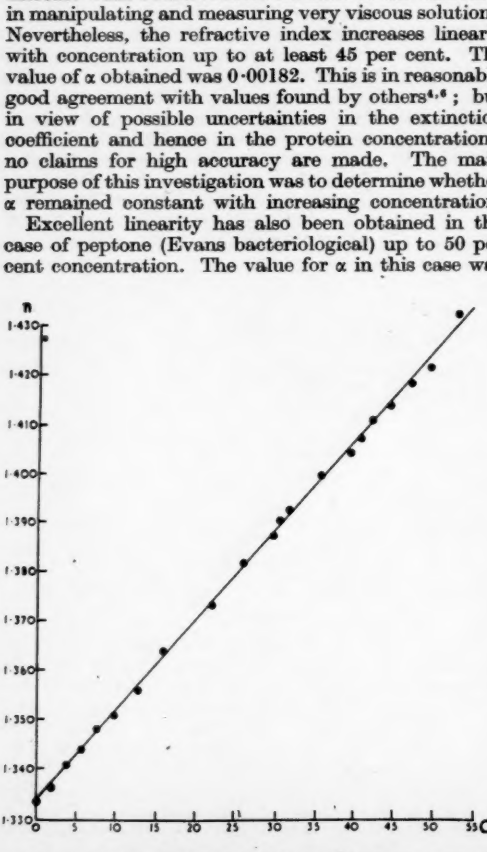


Fig. 1. Variation of refractive index (n) of bovine serum albumin solution with concentration (C)

These results suggest that: (1) unlike the sugars, at least some proteins and protein derivatives have constant values for α over a wide range of concentrations; (2) the breakdown of proteins into components of lower molecular weight has very little effect on α. This confirms the observation of Robertson[7] that complete digestion of sodium caseinate by trypsin had no detectable effect on the refractive index. We have also been unable to detect any change in refractive index during the digestion of bovine serum albumin by pepsin.

We wish to thank Dr. P. W. Kent for the loan of the refractometer. This work was assisted by a grant from the Medical Research Council to one of us (S. T.) and by grants from the Royal Society and the Rockefeller Foundation.

R. Barer
S. Tkaczyk

Department of Human Anatomy,
University Museum,
Oxford.
March 3.

[1] Barer, R., Ross, K. F. A., and Tkaczyk, S., *Nature*, **171**, 720 (1953).
[2] Barer, R., *Nature*, **169**, 366 (1952). Davies, H. G., and Wilkins, M. H. F., *Nature*, **169**, 541 (1952). Mitchison, J. M., and Swann, M. M., *Quart. J. Micro. Sci.*, **94**, 381 (1953).
[3] Howard, F. H., *J. Biol. Chem.*, **41**, 537 (1920).
[4] Armstrong, S. H., Budka, M. J. E., Morrison, K. C., and Hasen, M., *J. Amer. Chem. Soc.*, **69**, 1747 (1947).
[5] Cohn, E. J., *et al.*, *J. Amer. Chem. Soc.*, **69**, 1753, (1947).
[6] Perlmann, G. E., and Longsworth, L. G., *J. Amer. Chem. Soc.*, **70**, 2719 (1948). Halwer, M., *et al.*, *J. Amer. Chem. Soc.*, **73**, 2786 (1951).
[7] Robertson, T. B., *J. Biol. Chem.*, **12**, 23 (1912).

Cobalt as a Carcinogen

The effects of various metals on living cells in tissue culture are being investigated in this Laboratory, and a non-lethal disturbance of normal mitosis produced in chick fibroblasts by cobalt (as chloride) has already been reported[1]. This effect, which is characterized by the persistence of the nucleoli in mitotic cells throughout prophase into meta-, ana- and telo-phase, appears to be specific for cobalt, inasmuch as no comparable effect is produced by nickel, iron, zinc, chromium, manganese or beryllium in sublethal concentrations.

The cobalt is added to give a concentration of approximately 10×10^{-6} gm./ml. cobalt, to ordinary hanging-drop cultures after 24-hr. growth, when mitosis is approaching its peak; under these conditions, the effect reaches a maximum some 10–14 hr. later, when almost all dividing cells display persistent nucleoli. This type of culture begins to deteriorate after about 48 hr. unless the tissue is transplanted, and hence the prolonged action of cobalt on the cells cannot be studied. With the Maximow technique (double-coverslip method), in which the tissue can be washed and replenished with fresh medium without disturbing the cells, it is possible to prolong the life of the culture so that by adding the cobalt at some convenient point in the procedure, the effect can be observed over a longer period.

Some preliminary experiments on these lines produced at 72 hr. many giant cells in metaphase, each carrying one or more large cytoplasmic nucleoli.

Observation of such living cells in the warm chamber by phase-contrast illumination showed that they became reconstructed into mononucleate cells without any division taking place; the cell retains one or more large cytoplasmic nucleoli. These persistent cytoplasmic nucleoli are clearly demonstrated when the cultures are fixed in methyl alcohol or acetic – alcohol and stained with methyl green – pyronin. Stained by this method, the giant metaphase cells also show many pyronin-staining granules in the cytoplasm, which would appear to indicate an accumulation of ribonucleic acid.

These cellular changes produced *in vitro* were not lethal, and it seemed interesting to see what would happen if cobalt was allowed to act locally on an animal tissue *in vivo*. Accordingly, some pure 400-mesh cobalt powder was mixed with fowl serum, and a quantity of 0·028 gm. cobalt in 0·4 ml. serum was injected into the thigh muscles of rats 2–3 months old of the hooded strain. Ten male and ten female rats were so treated and a further ten male and ten female animals of the same strain and age were similarly injected with fowl serum only. There was little or no reaction immediately after the injection, and nothing was observed for some five months, when two male rats began to develop tumours at the site of injection. One month later, these tumours measured approximately 3 cm. × 3 cm. and at autopsy were found to be malignant neoplasms. I am indebted to Dr. A. Glücksmann of this Laboratory for the following report on the histological characteristics. One tumour was a highly cellular and fairly undifferentiated rhabdo-myo-fibrosarcoma and the other a cellular rhabdo-myo-fibrosarcoma with slightly better differentiation. The first one produced a definite lymph node metastasis. Sections of these tumours stained with methyl green – pyronin showed persistent nucleoli in a few of the mitotic cells. In addition to these two tumours in males, at six months one female began to show a tumour at the site of injection; this is still growing and is now approximately 3 cm. in diameter. At the present time—seven months from injection of the cobalt—two more females have tiny nodules at the site of injection.

Further experiments are in progress to repeat these observations and also to extend the work to other metals. The neoplastic process evoked may not be related in any way to the cytological effects observed *in vitro*. The fact that nickel can produce rat tumours[2] and yet does not cause the persistent nucleolar effect *in vitro* would seem to argue against any such relationship.

This work is being done with the support of the British Empire Cancer Campaign.

Note added in proof. The tumour in the female rat reached a size of approximately 4 cm. × 3 cm. at 7½ months, and histological examination by Dr. A. Glücksmann showed it to be a moderately differentiated fibrosarcoma with giant cell formation. This tumour was transplanted into other rats of the same strain, and so far 5 'takes' out of 20 have occurred. One of the nodules mentioned in a female rat developed into a cellular fibrosarcoma, and a further large tumour is growing in another male rat.

J. C. Heath

Strangeways Research Laboratory,
Wort's Causeway,
Cambridge.
Feb. 26.

[1] Heath, J. C., *Exp. Cell Res.* (In the press).
[2] Hueper W. C., *Texas Rep. on Biol. and Med.*, 10, 167 (1952).

Soluble Feather Keratin

The stability of feather keratin in the solid state is due to cross-linking of the polypeptide chains by hydrogen bonds, disulphide linkages and electrostatic forces, and under conditions where these bonds are broken solutions of the protein are obtained. The molecular characteristics of the particles in solution are of interest because of their relevance to the interpretation of the data obtained by the diffraction and scatter of X-rays by solid keratin, and the interaction of the particles in solution is relevant to the problem of the manufacture of fibres from the regenerated keratin. I wish to present here data of this sort for soluble feather keratin and in particular to identify the keratin monomer, which it was considered would be a particle in which bonding between the polypeptide chains due to hydrogen bonds, disulphide linkages and electrostatic attraction was absent.

80–85 per cent of chicken feather keratin dissolves in 10 *M* urea, 0·1 *M* bisulphite, 0·05 *M* phosphate (*p*H 6–8·5) after 18 hr. extraction at 40° C. The soluble protein, SH–keratin, remains in solution when the urea concentration is reduced to 5 *M*, and in this solution the cysteine – cystine ratio of the keratin is a function of the *p*H (Table 1).

When these solutions of SH–keratin are dialysed against water, a solution, or, when the protein concentration is greater than about 3 per cent, a gel, is produced. The solution or gel can be dried by sublimation to give a solid which contains no cysteine and 90 per cent of the cystine in the original feather; this is taken as evidence that few thio-ether or other stable cross-linkages are formed from the cystine and bisulphite. Treatment of this solid with performic acid gives a solution from which a protein (cysteic acid – keratin) can be recovered that contains neither cystine nor cysteine. In 0·05 *M* sodium carbonate, cysteic acid – keratin migrates with a single boundary on electrophoresis.

The graphs relating the osmotic pressure – concentration ratio to the concentration of SH–keratin in 5 *M* urea, 0·1 *M* bisulphite, 0·05 *M* phosphate, at *p*H 6 and at *p*H 8·5, and of cysteic acid–keratin in this solvent at *p*H 8·5, extrapolate with different slopes to the same value at zero concentration corresponding to a molecular weight of 10,000. Cysteic acid–keratin exhibits ideal behaviour in the concentration range 0–1 per cent, but SH–keratin deviates from ideal behaviour, indicating that association occurs with increasing concentration. In Table 1 the extent of the association is given as the ratio of the values of the osmotic pressure – concentration ratio at zero and 1 per cent concentration.

Measurements of light-scattering give confirmation of the association of SH–keratin at *p*H 8·5 and give a value of the weight average molecular weight of 11,000 in infinitely dilute solution.

From the intrinsic viscosity the axial ratio of SH–keratin in 5 *M* urea, 0·1 *M* bisulphite, 0·05 *M* phosphate (*p*H 8·5) and of cysteic acid–keratin in 5 *M* urea, 0·1 *M* sodium chloride, 0·05 *M* phosphate (*p*H 6) is 13 (calculated from Simha's equation[1], assuming that the proteins are unsolvated and are prolate ellipsoids). The specific viscosity of cysteic acid–keratin is independent of concentration in the range 0–1 per cent, but that of SH–keratin increases with increasing concentration; this is taken as evidence for the formation of increasingly asymmetrical particles by association.

Table 1. Osmotic Pressure and Cysteine–Cystine Content of Keratin in Urea Solution

The numbers of —SH and —S—S— groups are calculated on the basis of each monomer having a molecular weight of 10,000 and six potential SH groups. The molecular weight is obtained from the value of P/C at zero concentration

Solute	Solvent	*p*H	Mol. wt.	$\frac{*P/C : C = 0}{P/C : C = 1}$	No. of —SH groups in monomer	No. of S—S groups in monomer
SH–Keratin	5 *M* urea 0·1 *M* bisulphite 0·05 *M* phosphate	8·5	9,500	1·45	2·2	1·9
SH–Keratin	5 *M* urea 0·1 *M* bisulphite 0·05 *M* phosphate 0·2 *M* ethanol	8·5	9,500	1·58	2·4	1·8
SH–Keratin	5 *M* urea 0·1 *M* bisulphite 0·05 *M* phosphate 0·2 *M* mercapto-ethanol	8·5	9,700	1·09	—	—
Cysteic acid–keratin	5 *M* urea 0·1 *M* bisulphite 0·05 *M* phosphate	8·5	10,200	1	0	0

* P, osmotic pressure; C, concentration

SH–keratin in urea, bisulphite, phosphate (*p*H 8·5), and cysteic acid–keratin in urea, sodium chloride, phosphate (*p*H 6) each sediment with a single symmetrical boundary on ultracentrifugation in the synthetic boundary cell of Pickels, Harrington and Schachman[2]. Corrected for water at 20° as solvent, the sedimentation constant of each in infinitely dilute solution is 1·05 Svedberg units. This value, with the frictional ratio obtained from the viscosity data, gives the molecular weight as 10,100.

If the cysteine residues are equally distributed among the polypeptide chains of SH–keratin, then each particle of molecular weight 10,000 has potentially six SH groups. In Table 1 are given the number of —SH and —S—S— groups in each particle of keratin. Consideration of these results, together with the degrees of association that the osmotic pressure and light-scattering measurements reveal, suggests that the association only occurs when there are present both —SH and —S—S— groups. The addition of *B*-mercaptoethanol to a solution of SH–keratin in urea, bisulphite, phosphate at *p*H 8·5 decreases the degree of the association, whereas the addition of ethanol does not (Table 1). It is therefore possible that, with increasing concentration of SH–keratin, intermolecular —S—S— bonds form at the expense of intramolecular bonds through the intermediary action of the —SH groups[3]. The —S—S— bonds in SH–keratin in infinitely dilute solution are intramolecular, since the protein under these conditions has the same molecular weight as cysteic acid–keratin, which contains no cystine.

Further osmotic pressure measurements have shown that the molecular weight of keratin in infinitely dilute solution is constant in the range of urea concentration 10–5 *M*, of ionic strength 0·17–0·64, and for preparations which contain 0–2·9 gm. mol. cystine per 10,000 gm. keratin. It is therefore probable that under these conditions cross-linking of the polypeptide chains is absent and that we are indeed measuring the molecular size of the monomer.

I wish to thank Prof. K. J. Mysels for his advice during this work, which was done during the tenure of the Rubberset Fellowship of the University of Southern California and a Fulbright travel grant. The ultracentrifugation was done at the Sloan–Kettering Institute for Cancer Research, New York, and I am indebted to Dr. Mary L. Petermann for her hospitality and instruction. Full details of these experiments will be published in the *Biochemical Journal*.

A. M. Woodin*

Department of Chemistry,
University of Southern California,
Los Angeles 7.

* Present address: Institute of Ophthalmology, Judd Street, London, W.C.1.

[1] Simha, R., *J. Phys. Chem.*, **44**, 25 (1940).
[2] Pickels, E. G., Harrington, W. F., and Schachman, H. K., *Proc. U.S. Nat. Acad. Sci.*, **38**, 943 (1952).
[3] Huggins, C., Tapley, D. F., and Jensen, E. V., *Nature*, **167**, 592 (1951).

Physical State of Deoxyribonucleic Acid in Rat Thymus Homogenates

In a recent communication, Anderson[1] has shown that when the thymus of the freshly killed rat is homogenized and then dissolved in *M* sodium chloride, extremely viscous solutions are obtained. It is clear that the high viscosity is primarily due to the deoxyribonucleic acid present, but it is much greater than that of solutions containing the same amount of deoxyribonucleic acid isolated by the usual technique. To explain this discrepancy, Anderson suggested that in freshly prepared tissue homogenates deoxyribonucleic acid has a much higher molecular weight than the chemically isolated substance. This explanation is valid only if the deoxyribonucleic acid is molecularly dispersed in the tissue homogenates and does not interact with any other compound present. Using rat thymus homogenized in 0·14 *M* sodium chloride, filtered through nylon cloth and then diluted with an equal volume of 2 *M* sodium chloride, evidence has been obtained which suggests that the deoxyribonucleic acid is probably present in the form of aggregates in which nucleic acid molecules are cross-linked by protein bridges.

The homogenates, containing 0·020–0·003 per cent of deoxyribonucleic acid, were centrifuged at 80,000 *g* for five minutes. In all cases a clear non-viscous supernatant was obtained which could easily be poured off from the small gel-like pellet of sediment. Tests using the Dische diphenylamine reaction[2] showed that no deoxyribose was left in the supernatants. This high rate of sedimentation means that either aggregates are present or that the molecular weight of the deoxyribonucleic acid is far greater even than that suggested by Anderson.

The original homogenate in 0·14 *M* sodium chloride was centrifuged at low speed to remove debris and the insoluble deoxyribonucleoprotein, and the concentration of protein left in the supernatant was determined using the Mehl biuret method[3]. This was then compared with the concentration of protein in the supernatants obtained by centrifuging the *M* sodium chloride solutions at high speed as described above. It was found that the amounts of protein were the same to within 2 per cent. Since complete dissociation of the deoxyribonucleoprotein would have increased the protein concentration by 20 per cent, it can be concluded that either most of the histone has sedimented along with the deoxyribonucleic acid and therefore that in *M* sodium chloride dissociation is far from complete, or that any histone liberated by dissociation of the nucleoprotein has been replaced by other proteins.

Further evidence that the protein associated with the nucleic acid contributes to the viscosity has been obtained by hydrolysing it with chymotrypsin. Three solutions of the homogenate in *M* sodium chloride, one containing chymotrypsin and one deoxyribonuclease, were incubated at 25° C. for 16 hr. The presence of deoxyribonuclease reduced the viscosity to one-quarter of that of the solution containing no added enzyme, while the presence of chymotrypsin reduced the viscosity to one-half.

Viscosity measurements with the *M* sodium chloride solutions are unsatisfactory, first because of their inhomogeneity and secondly because they exhibit thixotropy. Chymotrypsin and deoxyribonuclease greatly reduce the thixotropic nature of the solutions. The viscosities of the solutions treated with enzymes have been compared with the viscosity of the untreated solution after this has been run through the viscometer a sufficient number of times for the rate of flow to become reasonably constant. When compared with the viscosity of an untreated solution which has been run several times through the viscometer, the effect of X-ray irradiation roughly parallels the effect on solutions of isolated nucleic acid[4]. 80 r. produces a barely significant fall in viscosity, 800 r. an appreciable decrease, and 8,000 r. a marked decrease.

Since deoxyribonucleic acid is still associated with protein and the protein contributes to the viscosity of this system, the viscosities cannot be used directly for determining the molecular weight of the nucleic acid.

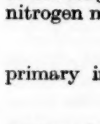
I thank Prof. J. A. V. Butler for his interest and advice during the course of this work. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

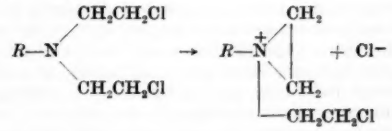
K. V. Shooter

Chester Beatty Research Institute,
Royal Cancer Hospital,
Fulham Road,
London, S.W.3.
Feb. 5.

[1] Anderson, G. A., *Nature*, **172**, 807 (1953).
[2] Allerton, R., Overend, W. G., and Stacey, M., *J. Chem. Soc.*, 255 (1952).
[3] Mehl, J., *J. Biol. Chem.*, **157**, 173 (1945).
[4] Butler, J. A. V., and Conway, B. E., *J. Chem. Soc.*, 3418 (1950).

Mutagenic Activity of Ethylenimine Picrate

Researches carried out during the past few years to investigate the precise mechanism of action of nitrogen mustards and related compounds suggest the primary importance of the  group, which appears in the molecule of nitrogen mustard, when in aqueous solution, through an intramolecular cyclization process:



Nitrogen mustard-like actions have been demonstrated in monofunctional compounds containing either a preformed ethylenimic ring or capable of forming it, and in ethylenimine itself[1–6].

On the other hand, Goldacre, Loveless and Ross[7] suggest that the presence of at least two functional groups in the molecule of mustard and related compounds is required to permit the molecule to react at two distinct points situated either on a single one or on two contiguous protein chains. There was therefore the possibility that cross-linkage could play a primary part in the mechanism of action of nitrogen mustards and related compounds.

In order to evaluate the importance of a single ethyleniminic group for the inhibition of aerobic glycolysis in neoplastic tissues, I began studying the action of ethylenimine picrate (kindly prepared by Simes Research Dept., Milan) during 1951. This substance was chosen from among several possible monoethyleniminic compounds because of its relatively higher stability.

Tests carried out, according to the Warburg technique, demonstrated that the inhibition-rates of Rous sarcoma and benzopyrene sarcoma glycolysis obtained by ethylenimine picrate were comparable to those obtained by methyl-*bis*(2-chloroethyl) amine, while inhibition obtained by picric acid is small[8].

It therefore became clear that the presence of a single ethyleniminic group was sufficient to permit an inhibition-rate of aerobic glycolysis in tumour cells comparable to that produced by bifunctional nitrogen mustards.

Consequently, it appears that, contrary to the hypothesis of cross-linkage, the presence of two or more functional groups is not required for a strong inhibition of neoplastic cell glycolysis.

Extending our researches on the mustard-like properties of ethylenimine picrate, we carried out investigations in *Drosophila melanogaster* in order to determine whether that substance has mutagenic activity.

The rate of mutation was estimated by the incidence of sex-linked lethals detected by the *ClB* test. The substance was mixed with the food of the larvæ in a concentration of 1×10^{-4}. The emerging ♂♂ were treated again by spraying the substance in a concentration of 1×10^{-3} for 8–10 min. and then mated to fresh ♀♀ virgin *ClB*.

The results obtained (see accompanying table) indicate that, at the concentration employed, ethyl-

Compound	No. of chromosomes tested	Lethals No.	Lethals %
Ethylenimine picrate	526	10	1·9
Picric acid	529	1	0·18
Controls	511	0	0

enimine picrate increases the sex-linked lethal mutation-rate quite significantly, while picric acid does not. Dubious, probably negative, data were obtained also by Auerbach and Robson[9] employing picric acid.

The demonstration of the mutagenic activity of ethylenimine picrate, together with the demonstration of its inhibitory action on aerobic glycolysis in neoplastic tissues, confirms the importance of the ethyleniminic ring in the mechanism of action of nitrogen mustards and ethyleniminic compounds, and affords additional evidence in favour of the assumption that the biological activity of mustards and ethyleniminic compounds is not essentially due to the cross-linkage mechanism.

Thanks are due to Prof. G. Montalenti for his many helpful suggestions, and to Profs. R. Dohrn and G. Montalenti for their kind hospitality.

Giuseppe Cardinali

Centro di Biologia del C.N.R.
e Istituto di Genetica,
Università di Napoli.
Jan. 10.

[1] Auerbach, C., and Moser, H., *Nature*, **166**, 1019 (1950).
[2] Biesele, J. I., Philips, F. S., Thierch, J. B., Burchenal, J. H., Buckley, S. M., and Stock, C. G., *Nature*, **166**, 1112 (1950).
[3] Jensen, K. A., Kirk, I., and Westergaard, M., *Nature*, **166**, 1020 (1950).
[4] Loveless, A., *Nature*, **167**, 338 (1951).
[5] Sjkvarnikov, P. K., *Dok. Akad. Nauk. U.S.S.R.*, **59**, 1337 (1948), as quoted by Jensen, K. A., Kirk, I., Kilmark, G., and Westergaard, M., Symp. Quant. Biol., **16**, 245 (1951).
[6] Stevens, C. M., and Mylroie, A., *Nature*, **166**, 1019 (1950).
[7] Goldacre, R. J., Loveless, A., and Ross, W. C. J., *Nature*, **163**, 667 (1949).
[8] Cardinali, G., *Tumori*, **39**, 183 (1953).
[9] Auerbach, C., and Robson, J. M., *Proc. Roy. Soc. Edin.*, B, **62**, 284 (1947).

Denitrification of Nitrite by a Species of *Achromobacter*

The effect of oxygen on the process of denitrification continues to be a subject of research, and it may, therefore, be of interest to record some observations made in the University of Melbourne with a species of *Achromobacter*. The organism, which was isolated from soil, reduced nitrite but not nitrate to nitrogen gas.

The organisms were harvested, after incubation for 48 hr. at 25° C., from the surface of a medium which contained: 'Difco' peptone, 10 gm.; 'Difco' yeast extract, 5 gm.; sodium chloride, 5 gm.; agar, 20 gm.; tap water, 1 litre; sodium nitrite (when supplied), 2 gm. The *p*H of this medium was between 6·8 and 7·2. Anaerobic incubation was carried out under nitrogen or hydrogen in anaerobic jars.

After harvesting, the cells were washed twice and suspended in *M*/15 phosphate buffer, *p*H 8. Borate buffer was not used because the nitrite reduction-rate was lower, although it was found that the oxygen absorption on sodium lactate remained unchanged. Cell suspensions obtained in different conditions were adjusted to the same turbidity for comparison of activity. The activity of cell suspensions was expressed as the rate of reduction of sodium nitrite in p.p.m./hr.

Table 1

Conditions of growth	Rate of reduction of sodium nitrite
Aerobic with sodium nitrite	180 p.p.m./hr.
Aerobic, no sodium nitrite	180 ,,
Anaerobic (hydrogen), with sodium nitrite	1,020 ,,
Anaerobic (hydrogen), no sodium nitrite	600 ,,
Anaerobic (nitrogen), with sodium nitrite	1,140 ,,
Anaerobic (nitrogen), no sodium nitrite	840 ,,

These rates were determined by following the disappearance of nitrite from the suspensions with sodium lactate, in excess, as the substrate. Suspensions were placed in a constant-temperature bath at 25° C. and were rendered anaerobic by the passage of a stream of nitrogen gas. Nitrite was estimated colorimetrically by the sulphanilic acid – α-naphthylamine method. Nitrite was added to give an initial concentration of about 200 p.p.m., and this initial concentration was estimated.

Table 1 shows the effect of the presence and absence of oxygen on cultures growing with and without nitrite.

These results indicated that the absence of oxygen was a more important factor than the presence of nitrite in the production of highly active cells. Under anaerobic conditions, growth was very slight; but highly active cells could be produced in good yields if a period of anaerobic growth followed an initial aerobic growth. Anaerobic incubation of washed suspensions of cells grown aerobically did not result in increased activity.

A pronounced reduction of 'nitritase' activity was found in media rendered deficient in iron, and the addition of 0·5 p.p.m. of iron, supplied as ferrous sulphate, resulted in cells of normal activity. Owing to the use of solid media, the iron requirement is not accurately known.

Spectroscopic examination of cell suspensions of widely different 'nitritase' activity did not show any relation between the intensity of cytochrome bands and the degree of activity.

The rate of reduction of nitrite did not differ when the reaction was carried out under hydrogen and nitrogen. It therefore did not appear likely that hydrogenase was involved.

Some inhibitor studies were made both with whole cells and with cell-free extracts which were prepared by shaking heavy suspensions with Ballotini beads. The cell debris was removed by centrifugation. The results given in Table 2 are regarded as an initial

Table 2

Inhibitor	Concentration	Preparation	Inhibition
Potassium cyanide	*M*/10,000	whole cells	73
Potassium cyanide	*M*/1,000	whole cells	100
Potassium cyanide	*M*/1,000	extract	85
Hydroxylamine	*M*/500	whole cells	50
Hydroxylamine	*M*/400	extract	90–100
Sodium azide	*M*/500	whole cells (18 hr. exposed)	46
Sodium azide	*M*/200	extract	40
8-Hydroxyquinoline	*M*/1,000	whole cells	72
Carbon monoxide	qualitative	whole cells extract	inhibited and partly reversed by light
Hydrogen sulphide	qualitative	whole cells	inhibited
Copper sulphate	*M*/1,000	whole cells	99
Silver nitrate	*M*/1,000	whole cells	98
Phenylmercuric acetate	*M*/2,500	whole cells	84
Phenylmercuric acetate	*M*/5,000	extract	80–100
m-Amino *p*-hydroxyphenylarsenoxide	*M*/500	whole cells	92
m-Amino *p*-hydroxyphenylarsenoxide	*M*/1,000	extract	85

survey only. The inhibiting compounds have not been tested over a range of concentrations. Differences have been found in the behaviour of whole cells and extracts. Evidence was also found that the *p*H optimum of cell extracts was nearer *p*H 7 than 8. It should be noted that azide interferes with the colorimetric estimation of nitrite in such a way as to give lower than actual inhibition figures. To avoid this difficulty, the percentage inhibition for azide with a cell extract was derived from the measurement of nitrogen production manometrically. The results quoted are the percentage inhibition of the rate of nitrite reduction.

Inhibition by the last two compounds was relieved by the addition of thioglycollic acid. Tryparsamide did not inhibit. It is possible that a part of the enzyme system involves an active sulphydryl group which is produced under anaerobic conditions. This may not be specifically related to the 'nitritase' system, since an increased activity followed anaerobic growth in the absence of nitrite.

JEAN B. YOUATT

Department of Biochemistry,
University of Leeds.
Jan. 16.

Effect of DDT on the Metabolism of Khapli Wheat Seedlings

JOHNSON[1] reported that DDT (dichlorodiphenyltrichloroethane) affected the metabolism of Khapli wheat so that the seedling leaves became susceptible to a race of *Puccinia graminis* var. *tritici* to which they are normally resistant. The response to DDT was highly specific, as only one other of the resistant wheats tested (Arnautka) showed any indication of susceptibility consequent on spraying.

To determine the specific nature of the response of Khapli wheat leaves to DDT, alcoholic extracts were obtained from DDT-treated and non-treated leaves, 2, 6, 9 and 14 days after treatment. The extracts were concentrated *in vacuo* and, after a short period of storage in toluene, they were chromatographed using *n*-butanol – formic acid – water mixture as used by Wiggins and Howarth[2]. A visual comparison of the spots on the chromatograph revealed a marked change, as a consequence of the leaf being sprayed with DDT solution, in the concentration of amino-acids present in sufficient quantity to be detected by 0·1 per cent ninhydrin. Whenever an amino-acid is present in both the extract from the control and the treated leaves, it is present in greater amount in the latter.

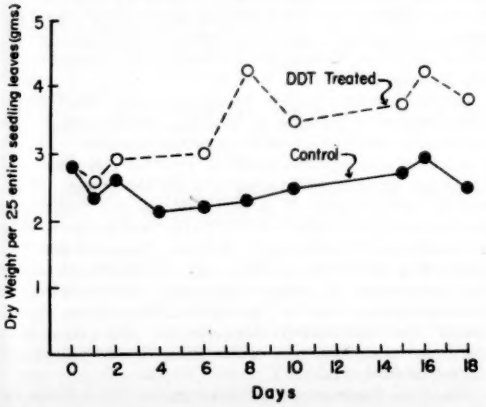


Fig. 1. The effect of DDT, during ontogeny, on the dry weight of the seedling leaf of Khapli wheat

Preliminary results with the chromatography of the simple sugars present in the alcoholic extracts reveal that they also are present in greater quantities in the DDT-treated leaves than in the non-treated leaves.

This study is part of an attempt to determine the nature of rust resistance. Evidently the DDT alters the metabolism in such a way that free amino-acids and simple sugars accumulate in the leaf. The effect may be due to an inhibition of synthesis of proteins and carbohydrates. However, the dry weight of the treated seedling leaf increases more rapidly than does that of the non-treated leaf (see Fig. 1). This would suggest that certain substances that normally are transported during the ontogeny of the leaf are not translocated from the treated seedling leaf. In any event, the observations recorded here prove that DDT extensively alters the metabolism of the Khapli wheat seedling. Further study should reveal which, if any, of these alterations are responsible for the increase in susceptibility of the seedling.

F. R. FORSYTH

Plant Pathology Laboratory,
Science Service, Canada Agriculture,
Winnipeg, Manitoba.
Oct. 28.

[1] Johnson, T., *Can. J. Res.*, C, **24**, 23 (1946).
[2] Wiggins, L. F., and Howarth, W. J., *Nature*, **170**, 279 (1952).

Development of the Syncytial Endosperm of *Cocos nucifera*

DUTT[1] has recently summarized her investigations on nuclear behaviour in the developing endosperm of *Cocos nucifera*. Several of her observations are at variance with statements we have previously made[2,3] and with some of our more recent findings[4]. Since these divergent opinions arise in part from a difference in terminology and in part from misinterpretations of the anatomical structure of the coconut, we wish to present several points to clarify this matter.

Following fertilization, the embryo sac of *Cocos* enlarges rapidly and becomes filled with a clear watery fluid (milk) in which large amœboid nuclei and fine cytoplasmic particles are suspended. This milk will be referred to as the 'liquid syncytium'. Dutt has not been able to detect free nuclei in this liquid syncytium in the early stages of its development; but they may be easily demonstrated by centrifuging the milk and examining the sediment. Since they are widely dispersed in the liquid they might easily be overlooked in unconcentrated milk. After fertilization, and until the fruit reaches an overall length of approximately 150 mm., an examination of the sac cavity reveals that its boundary is composed of a closely packed layer of isodiametric cells which represents the specialized wall of the inner integument. According to Quisumbing and Juliano[5], the nucellus is digested prior to fertilization, and therefore this specialized cell layer probably represents an integumentary tapetum or endothelium. The endothelium is in direct contact with the milk and there is no cellular endosperm present at this stage. We have previously referred to this layer as

the nucellus under the mistaken impression that this tissue was persistent. As the fruit reaches an overall length of approximately 100 mm. a number of large spherical cells suddenly appear suspended in the liquid syncytium. These cells, which may range from 50 to 300 μ in diameter, show varying numbers of nuclei (1–40). Our observations indicate that these cells, or endosperm vesicles, are formed in the liquid syncytium by the coalescence of cytoplasmic particles around nuclei or groups of nuclei which are floating free in the milk. Dutt has not mentioned these endosperm vesicles.

At a later stage when the fruit is approximately 150 mm. in length these endosperm vesicles and the free nuclei of the liquid syncytium commence to settle out of the milk and attach themselves to the surface of the endothelium. This deposition of vesicles and free nuclei commences at the lower end of the embryo sac cavity and progresses upward around the walls of the sac, thus forming a gelatinous syncytium in which the nuclei are very closely packed. This gelatinous mass of nuclei and cytoplasm soon becomes cellular, forming the meristem which develops the solid endosperm or familiar coconut meat. Dutt states that this meristem develops first at the micropylar end of the sac cavity and creeps progressively over the face of the endocarp, finally covering the entire wall of the cavity. She is apparently under the impression that the micropyle is located at the lower end of the cavity. Actually, however, since the ovule of *Cocos* is anatropus the micropyle lies directly below the hilum or soft eye at the stem end of the nut. As would be expected, the embryo is seated directly below the micropyle. Therefore, the stylar end of the fruit is oriented downwards as the fruit hangs on the palm, and the endosperm meristem is initiated at the antipodal end of the sac. Also, as pointed out above, this meristem forms on the endothelial surface and not on the endocarp, which is separated from the cavity by two thick integuments.

There is also some divergence between our observations[3] and those of Dutt on the mode of nuclear division in the ripening embryo sac, since we have never been able to detect any mitotic divisions in the free nuclei of the milk, in the endosperm vesicles or in the younger stages of the gelatinous syncytium. In Dutt's opinion, mitosis occurs during all these stages, and she figures a nucleus in mitosis in a drop of milk. Since she claims not to have found any free nuclei in the milk "until a little of the endosperm, if only the barest film, has begun to form", it is probable that the nuclei she pictures were torn from the meristematic endosperm during the opening of the nut. We have frequently noted at this stage that large plates of meristematic cells will detach themselves from the endothelial walls, break up and float free in the milk if the nut is shaken. In the young cellular meristem at this stage mitoses are frequent. On the other hand, in the stages prior to formation of the meristem, we find that constricted or fragmenting nuclei are very abundant in both milk and endosperm vesicles. We have, however, found no evidence of spindle formation in connexion with these constricting nuclei, which leads us to believe that amitosis rather than mitotic division is characteristic of the syncytial stages. In addition, there are always numerous pycnotic nuclei here, which is suggestive of amitosis. While it is possible that the amitotic figures observed actually represent stages of nuclear fusion, this does not seem likely since the greatest frequency of amitotic figures in the liquid syncytium is encountered at the same stage in development when the maximum number of nuclei appear there.

On all other features of the development of the fertilized embryo sac Dutt's observations and ours are in agreement.

This investigation has been aided by a grant from the American Cancer Society upon recommendation of the Committee on Growth, National Research Council.

Victor M. Cutter, jun.
Bessie Freeman

Department of Biology,
The Woman's College,
University of North Carolina,
Greensboro, North Carolina.
Jan. 18.

[1] Dutt, M., *Nature*, **171**, 799 (1953).
[2] Cutter, V. M., Wilson, K. S., and Dubé, G. R., *Science*, **115**, 58 (1952).
[3] Cutter, V. M., Wilson, K. S., and Dubé, J. F., *Amer. J. Bot.*, **39**, 51 (1952).
[4] Cutter, V. M., Wilson, K. S., and Freeman, B., *Amer. J. Bot.* (in the press).
[5] Quisumbing, E., and Juliano, J. B., *Bot. Gaz.*, **84**, 279 (1927).

Control of Mitotic Activity

The mechanically active phase of nuclear reproduction is closely associated with the appearance of polymerized deoxyribonucleic acid (DNA) on the chromosomes. Furthermore, it has been shown that cells containing little or no DNA do not divide[1] and that continued synthesis of this form of nucleic acid is essential for further nuclear reproduction[2]. The actual synthesis of DNA appears to take place during interphase[2,3], although it is not yet fully established whether it is produced directly from the store of ribose nucleic acid (RNA) or from other sources. But whatever the processes involved, any modification leading to the disappearance or reduction of deoxyribonucleic acid from the cell will act as a mechanism whereby nuclear division may be regulated.

Such a mechanism appears to operate in the embryo sacs of *Vicia faba*, *V. sativa* and *Lens esculenta*, which I have been studying in relation to fertilization and embryo development. The differentiated egg and central fusion nuclei, which are not required to divide until the time of fusion with the male gametic nuclei, contain little or no DNA. With these nuclei, Feulgen gives a completely negative reaction while the methyl green–pyronin technique indicates the presence of ribonucleic acid only.

In the mature pollen grains, on the other hand, the generative nucleus is Feulgen-positive while the vegetative nucleus gives a negative reaction. This is similar to the observations of Painter[4], Koller[5] and La Cour[6] on the pollen grains of *Tradescantia*. Thus, during the process of differentiation the vegetative nucleus, which does not undergo further division, loses the ability to synthesize DNA. Support for this concept is provided by the case of *Sorghum*[7], where the presence of supernumerary heterochromatic chromosomes, with a different DNA cycle, brings about the continued division of the vegetative nucleus, resulting in what has been called an 'encapsulated tumour'.

Thus, in contrast to the absence of DNA from the mature egg, central fusion and pollen tube nuclei which do not divide further, we have the generative

nucleus, which contains DNA, invariably dividing to produce two male gametic nuclei, both of which also contain DNA. Here it is interesting to note that Coulter and Chamberlain[8] as far back as 1903 were able to differentiate between the female and male nuclei in the embryo sac on the basis of staining reactions without, however, realizing its significance.

From these observations we may further suggest that the division of the fertilized egg and central fusion nuclei is initiated by the re-introduction of DNA by the male nuclei. A similar explanation would also apply for the normal development of sea urchin eggs, where again only the sperm nucleus appears to contain deoxyribonucleic acid.

This view that DNA synthesis provides a regulating mechanism for nuclear activity has wider implications, of which the following may be mentioned.

(*a*) The reference by Darlington and Mather[9] to the apparent development of vetch plants from lentil seed can now be seen in a different light. Only the male vetch nucleus contains the DNA necessary for further development on failure of fertilization, thus supporting the suggestion of androgenesis (male parthenogenesis).

(*b*) If the egg nucleus in the embryo sac never contains DNA, then it is difficult to understand how an embryo can develop in apomictic forms of reproduction where the male gametic nuclei play no part. There is some evidence, however, that the egg in apomictic forms of *Rubus*[10] does contain DNA, and this may be associated with the fact that the embryo sac has developed directly from a somatic cell.

Further work is in progress in an attempt to establish more precisely the conditions which determine, on one hand, a discontinuance of nuclear division in the haplophase and, on the other, the resumption of division in the diplophase. It forms part of an investigation being carried out with the aid of a grant from the Agricultural Research Council and under the helpful guidance of Prof. P. T. Thomas.

D. G. Rowlands

Department of Agricultural Botany,
University College of Wales,
Aberystwyth.
Jan. 29.

[1] Brachet, J., *Symp. Soc. Exp. Biol.*, **6**, 173 (1952).
[2] Walker, P. M. B., and Yates, Helen, *Proc. Roy. Soc.*, B, **140**, 274 (1952).
[3] Davidson, J. N., "The Biochemistry of the Nucleic Acids", 112 (1950).
[4] Painter, *Bot. Gaz.*, **105**, 58 (1943).
[5] Koller, P. C., *Proc. Roy. Soc. Edin.*, B, **51**, 398 (1943).
[6] La Cour, L. F., *Heredity*, **3**, 319 (1949).
[7] Darlington, C. D., and Thomas, P. T., *Proc. Roy. Soc.*, B, **130**, 127 (1941).
[8] Coulter, J. M., and Chamberlain, C. J., "Morphology of Angiosperms" (1903).
[9] Darlington, C. D., and Mather, K., "Elements of Genetics" (1949).
[10] Crane, M. B., and Thomas, P. T., *J. Genet.*, **40**, 109 (1940).

Chemical Composition of the Cell Wall of *Coccidioides immitis*

The taxonomic position of *Coccidioides immitis*, the causative agent of coccidioidomycosis, has been debated for some time. It is evident from the method of endosporulation exhibited both in the parasitic phase and under certain cultural conditions[1,2] that the mature *Coccidioides* cell is a sporangium and the endospores, sporangiospores. This indicates a probable relationship with the Phycomycetes[3,4] and even possibly with the sub-class, Zygomycetes[5]. However, certain characteristics inconsistent with such a relationship, including the development of a richly septate mycelium and the absence of definite sporangiophores, present some taxonomic difficulties. Nevertheless, as noted by Emmons[5], the sporangia of many of the Zygomycetes (for example, *Mortierella* and *Syncephalis*) present so many anomalies that *Coccidioides* may well find a place within the group. Frey[6] has shown that the Phycomycetes may be divided into two distinct groups: the one having cellulose (Oomycetes), the other having chitin (Blastocladiales and Zygomycetes) as skeletal material of their cell walls. Therefore, we thought it might be of interest to isolate and identify the non-water-soluble polysaccharide forming the skeleton of the cell wall of *C. immitis*.

A mixture of strains 2150 and 2200, both of which had been received originally from Dr. N. F. Conant, of Duke University Medical School, Durham, North Carolina, were grown at room temperature in shake culture in two half-litre Fernbach flasks in 1 litre of a trypsin digest of beef-heart medium containing 2 per cent glucose. The *p*H of the medium was 7·6. Massive amounts of growth were obtained on this medium in 3–5 days. The cultures were killed on the fifth day by autoclaving at 10-lb. pressure for thirty minutes and the growth was harvested by filtration. The material was washed repeatedly with distilled water on a Buchner funnel to remove the adhering medium and the mycelium was then dried in an oven at 90°–110° C.

The dried mycelium was extracted and oxidized as described by Scholl[7]. Debye–Scherrer diagrams of the isolated substance were very kindly prepared for us by Dr. W. Epprecht, Eidgenössische Materialprüfungs- und Versuchsanstalt, Zürich. These showed the typical powder pattern for chitin; there were no diffraction lines for cellulose. Nitrogen determinations confirmed these findings (N = 5·68, 5·85 per cent).

The isolation of chitin from the mycelium of *C. immitis* is consistent with Frey's findings in the Zygomycetes. It does not allow any definite conclusion as to the taxonomic position of this organism since chitin forms the skeletal material of fungi other than the Phycomycetes. Nevertheless, it does show that all fungi pathogenic for man and animals, whether they parasitize the keratin of hairs, skin or nails or the deeper tissues, have chitin as skeletal material of their cell walls[8,9].

F. Blank

Department of Bacteriology and Immunology,
McGill University,
Montreal.

Ruth C. Burke*

Department of Bacteriology and Immunology
and the Harvard Mycology Laboratory,
Harvard Medical School,
Boston, Massachusetts.
Jan. 20.

* Present address: Osborn Botanical Laboratory, Yale University, New Haven, Connecticut.

[1] Baker, E. E., Mrak, E. M., and Smith, C. E., *Farlowia*, **1**, 199 (1948)
[2] Burke, Ruth C., *Proc. Soc. Exp. Biol. Med.*, **76**, 332 (1951).
[3] Hartmann, M., *Centr. Bakt.*, 1. Abt. Ref. Beiheft, **54**, 253 (1912).
[4] Langeron, M., in "Nouveau Traité de Médecine", **4**, 479 (Masson et Cie., Paris, 1922).
[5] Skinner, C. E., Emmons, C. W., and Tsuchiya, H. M., Henrici's "Molds, Yeasts and Actinomycetes", 2nd edit. (John Wiley and Sons, New York, 1947).
[6] Frey, R., *Ber. Schweiz. Bot. Ges.*, **60**, 199 (1950).
[7] Scholl, E., *Monatsh.*, **29**, 1023 (1908).
[8] Blank, F., *Biochim. et Biophys. Acta*, **10**, 110 (1953).
[9] Blank, F., *Can. J. Microbiol.* (in the press).

A Cyanocobalamin–Protein Complex from Sow's Milk and Desiccated Pig Stomach

We have already reported the partial purification from sow's milk and desiccated pig stomach of proteins which combine with cyanocobalamin and the vitamin B_{12}-like substances having different nucleotide groups[1]. Purification of the protein from sow's milk whey was achieved by continuous electrophoresis on paper[2]. Because of the labile nature of the protein itself, we found it easier to saturate the impure concentrate with cyanocobalamin labelled with cobalt-60 and to isolate the cyanocobalamin–protein complex. Purification of this complex by continuous electrophoresis on paper[2] was followed by repeated fractionation with *iso*propyl alcohol at − 5°. A recent preliminary note by Wijmenga, Thompson, Stern and O'Connell[3], concerning a similar cyanocobalamin–protein from pig gastric mucosa, has prompted us to give a brief account of the properties of our substance isolated from sow's milk. Full experimental details will be published elsewhere.

The pink protein complex from sow's milk has the absorption spectrum shown in Fig. 1. The absorption at 278 mμ is largely due to protein ($E(1\%, 1\text{ cm.}) = 15{\cdot}1$) and at 362 mμ to cyanocobalamin ($E(1\%, 1\text{ cm.}) = 5{\cdot}7$). The total nitrogen (micro-Kjeldahl) is 16·1 per cent, and 1 mgm. of the complex contains 23·6 μgm. cyanocobalamin. From these figures, and assuming that one molecule of protein combines with one molecule of cyanocobalamin (mol. wt. = 1,300), the molecular weight of the protein would be 55,000. Qualitative examination of the hydrolysed complex shows an amino-acid pattern typical of proteins. Spectroscopic investigations, by the method of Holiday[4], shows the rather high tyrosine content of 17·6 per cent. The presence of 7 per cent hexosamine suggests a glycoprotein rather than a mucoprotein.

Cyanocobalamin exists in the milk of the sow, woman, rat, goat and cow in bound forms. Gregory, Ford and Kon[5] showed that sow's milk, but not cow's milk, combined with added cyanocobalamin. However, this procedure involved heating the milks with the assay medium. We have since developed an ultra-filtration method which shows that all these milks when raw and untreated can bind some added cyanocobalamin. Compared with sow's milk, the amount bound by the other milks is small. The electrophoretic mobility of the naturally occurring bound cyanocobalamin in all the milks and of the complexes formed by adding cyanocobalamin to these milks or to desiccated pig stomach was $-3{\cdot}1 \times 10^{-5}$ cm.^{2} V.$^{-1}$ sec.$^{-1}$ at *p*H 8·6, $\mu = 0{\cdot}05$.

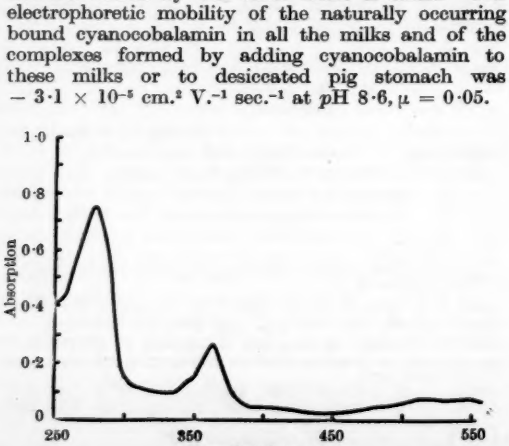


Fig. 1. Absorption curve of cyanocobalamin – protein complex in aqueous solution (0·5 mgm./ml.)

We have also investigated the mode of linkage between cyanocobalamin and the protein. Removal of the nucleotide and the most labile amide group from the cyanocobalamin molecule[6] did not prevent its combination, but hydrolysis to the hexa- or hepta-acids[6] gave a substance which could no longer be combined with the protein. The absorption curve (Fig. 1) with a peak at 362 mμ suggests that the complex contains cyano- rather than hydroxo-cobalamin. When ^{14}CN-labelled cyanocobalamin was added to the partially purified binding protein from pig stomach and the whole was dialysed, no radio-activity could be detected in the dialysate. After purification (as described above), the pink protein complex still contained carbon-14 activity, indicating that the protein did not displace the cyanide during combination with the vitamin.

Specific groups on the molecule of the protein isolated from sow's milk were blocked by various reagents, and the capacity of the modified protein to bind cyanocobalamin was measured. Free —SH groups were not necessary for the binding. An $-NH_2$ or > NH group may be involved since, after reacting with fluorodinitrobenzene, the protein no longer bound cyanocobalamin. However, milder treatments for blocking $-NH_2$ groups, such as 3 per cent formaldehyde at *p*H 8 or an acetylation procedure using acetylthioethylacetamide at *p*H 10^7, did not interfere with the binding.

For a quantitative microbiological estimation of the cyanocobalamin in the complex, preliminary digestion with papain or trypsin is necessary. Enzyme digestion converts the microbiologically inactive cyanocobalamin complex into a form fully active for *Lactobacillus leichmannii* when heated with the assay medium but having only 20 per cent of this activity when assayed unheated. Furthermore, ultra-filtrations of the unheated and heated digests showed that not more than 10 per cent of the total cyanocobalamin had become ultra-filtrable. Since cyanocobalamin itself can be ultra-filtered quantitatively, it appears possible that the digest contains peptide conjugates of cyanocobalamin.

There seems no doubt that the substance isolated by us from sow's milk is very similar to the cyanocobalamin–protein isolated by Wijmenga *et al.* from hog gastric mucosa. The only discrepancy is that we find that 1 mgm. of the complex contains 23·6 μgm. cyanocobalamin, whereas Wijmenga *et al.* find only 12·3 μgm.

We wish to thank Dr. E. Lester Smith (Glaxo Laboratories) for gifts of ^{60}Co cyanocobalamin and ^{14}CN cobalamin and the cyanocobalamin hydrolysis products, and Dr. S. K. Kon for his advice and interest in this work.

Margaret E. Gregory
E. S. Holdsworth

National Institute for Research in Dairying,
University of Reading.
Feb. 15.

[1] Gregory, M. E., and Holdsworth, E. S., *Biochem. J.*, **55**, 830 (1953).
[2] Holdsworth, E. S., *Biochem. J.*, **55**, xiv (1953).
[3] Wijmenga, H. G., Thompson, K. W., Stern, K. G., and O'Connell, D. J., *Biochim. et Biophys. Acta*, **13**, 144 (1954).
[4] Holiday, E. R., *Biochem. J.*, **30**, 1795 (1936).
[5] Gregory, M. E., Ford, J. E., and Kon, S. K., *Biochem. J.*, **51**, xxix (1952).
[6] Armitage, J. B., Cannon, J. R., Johnson, A. W., Parker, L. F. J., Smith, E. L., Stafford, W. H., and Todd, A. R., *J. Chem. Soc.*, 3849 (1953).
[7] Baddiley, J., Kekwick, R. A., and Thain, E. M., *Nature*, **170**, 968 (1952).

Odour and Chemical Constitution

NOTHING is known of the mechanism by which small amounts of odorous material can trigger nervous impulses leading to smell sensations, because the characteristic odour of a substance has not hitherto been securely correlated with any other characteristic property of its molecules.

Some years ago, G. M. Dyson[1] concluded that odour must be related to a characteristic molecular vibration pattern, and he assigned certain odours to certain Raman frequencies ("osmic frequencies") in the general range 1,500–3,000 cm.$^{-1}$. In this region, Raman lines are correlated strongly with particular functional groups (OH, SH, CO, etc.), so that if odour could be correlated with these frequencies it could equally well be correlated with the corresponding functional groups and there would be no need for a vibrational theory of odour. On the other hand, Raman lines below about 1,000 cm.$^{-1}$ appear to depend upon the whole configuration of the molecule more than on the constituent groups. Odour also appears to depend more on the whole configuration of the molecule, so that a correlation of odour with vibration would be more reasonable at low frequencies than at high. Moreover, the Planck formula shows that only normal vibrations with a wave number considerably less than 1,000 cm.$^{-1}$ have a significant probability of being active at body temperature.

Dyson's 'osmic frequencies" are therefore excluded on both chemical and quantum grounds, and any correlation between odours and molecular vibration patterns must be looked for at frequencies below about 700 cm.$^{-1}$ corresponding to absorption in the infra-red beyond about 15 microns. This region does not seem to have been previously searched for odour correlations.

A panel of fifteen observers was used to select sixteen compounds with an odour resembling that of nitrobenzene. Of these compounds, all but one (nitrothiophene) were benzene derivatives, and all but one (*iso*coumarane) had multiple bonds in the side-chain conjugated with the ring. Apart from this general similarity of type, the compounds had such varied functional groups as nitro, nitrile, aldehyde, ketone, ester, etc. When the low-frequency Raman shifts of these compounds were scrutinized, there was some evidence of a statistically significant correlation between the odour and the pattern of the Raman lines. This work is being reported in detail elsewhere.

The Raman frequencies below 800 cm.$^{-1}$ of three of these compounds (nitrobenzene, nitrothiophene and benzonitrile) are shown in Fig. 1. A search of the literature for substances with unrelated structures but similar Raman spectra showed that butyronitrile met the requirements fairly well. In the opinion of six observers, its odour is somewhat almond-like. The successful selection at the first attempt of an aliphatic compound with the same general type of odour as a group of sixteen aromatic substances is something which no other theory of the physical basis of odour would enable one to do.

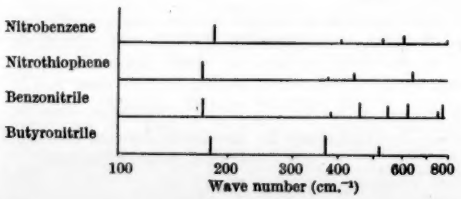


Fig. 1

A correlation of odour with the pattern of molecular vibrations may therefore be possible if the frequency-range below 1,000 cm.$^{-1}$ is studied. The Raman effect is at the present the most convenient tool for the purpose.

R. H. WRIGHT

Division of Chemistry,
British Columbia Research Council,
Vancouver 8, B.C.
Jan. 27.

[1] Dyson, G. M., *Perf. Essent. Oil Record*, **19**, 456 (1928); **28**, 13 (1937); *Chem. and Indust.*, **16**, 647 (1938).

IN the early 'twenties when the first work on this aspect of osmics was under active consideration our knowledge of the Raman lines below 1,000 cm.$^{-1}$ was rudimentary, and while correlation between structural groups and the higher frequencies is now fairly well established, the need for a vibrational theory of odour does not, in my view, automatically disappear.

The interesting results established by Mr. R. H. Wright prove, if they prove anything, that the original hypothesis correlating odour specificity with molecular vibration was sound in principle, but that I was wrong in assuming the frequencies concerned to be those in the higher Raman ranges. He has made a valuable advance in this field by focusing attention on the significance of the lower frequencies; they relate to the molecule as a whole and this, in itself, is an attractive development of the original thesis. There are, however, several groups of compounds which must come under review before the theory can be fully accepted: I refer in particular (*a*) to the group $R.C_6H_4.NCS$ which, when $R=H$, $o-CH_3$ or $o-Cl$, retains the mustard-like odour associated with allylthiocarbimide, but when $R=CH_3$, $p-Cl$, $p-OCH_3$, acquires a strong odour resembling anisaldehyde (*en passant*, 4-cyanophenylthiocarbimide has a strong almond component to its odour); (*b*) the 'camphor-like' groups in which such diverse substances as camphor, hexachloroethane, benzene hexachloride and perchloronaphthalene have closely related odours; and (*c*) the 'tea-rose' thiazoles of Bogert. which have odours reminiscent of phenyl acetaldehyde or the esters of phenylacetic acid.

G. MALCOLM DYSON

1 Burton Walks,
Loughborough.

Effect of Flight on Behaviour of *Aphis fabae* Scop.

AFTER a preliminary period of quiescence newly moulted alate alienicolae of *Aphis fabae* Scop. take flight, in suitable physical conditions, whatever the quality of the host they are on. When they alight on a host plant after a sufficient flight they do not take off again immediately[1] as they do before sufficient flight[2], and they may settle down and bear young. Moericke[2] thought that this indicated two phases in the life of alate aphids, the *Zugphase* and *Befallsphase*, and Müller and Unger[3] attributed the transition from one to the other to exhaustion. The following experiments show that the change can be brought about by flight itself, and that it is not necessarily permanent.

The experiments were carried out in a greenhouse and the laboratory at temperatures between 20 and

30° C., on alatæ from laboratory cultures and natural infestations of broadbeans (*Vicia faba* L.).

The aphids were given flight exercise by attaching them by the thorax to small pins with water-colour paint, and also by permitting untethered flight in the greenhouse. In this way it was shown that a very short flight of an average of about 20 sec. was sufficient to result in the changed behaviour when the aphids were returned to their host plants. The change could be induced by longer periods of activity other than flight, as when the aphids were kept in the light for several hours in a narrow glass tube in which they were able to crawl but unable to fly.

Aphids alighting on a host plant after sufficient flight wander about for several minutes and whether they stay or leave is influenced by the host suitability. Flown aphids placed on highly suitable hosts (6 cm. high broadbean seedlings) settled and remained there until they had lost the ability to fly; on less suitable hosts (isolated mature broadbean leaves) they took off again. Aphids placed on young plants of broadbean 1 metre high showed a considerable variation in behaviour after wandering; a few remained but most of them took off again, this agreeing with the field observations of other workers[1,4].

Parturition occurs soon after the aphids settle down on seedlings after flight, or are confined after flight on mature leaves in the dark; its initial rate is influenced by the state of development of the embryos and not by the quality of the host[5]. Nor is it necessary for the aphids to feed for them to stay and bear young, contrary to the assumption of Kennedy and Booth[6]. When unflown aphids are confined on host plants by darkness from flight maturity, embryonic development continues but no larvæ are born for two days or more, although several hours after reaching flight maturity the ovaries contain 8–12 fully formed embryos. Such aphids when flown commenced to bear young within an hour of settling, and a number of larvæ were then born at half-hourly intervals; an average of $9{\cdot}0 \pm 0{\cdot}24$ larvæ were born overnight ($n = 77$). Aphids flown as soon as they reached flight maturity gave birth to an average of only $3{\cdot}4 \pm 0{\cdot}20$ larvæ overnight ($n = 50$). Anything, therefore, which delays the initial take-off of the aphids from their parent host plant will help to reduce the length of their flying life by increasing the number of larvæ born in the first batch and so hastening the processes leading to the autolysis of the flight muscles[7].

Young aphids which have alighted on an unsuitable host or have been disturbed while feeding on a suitable host may take off again, and a further short flight is necessary before they will settle down to feed and reproduce.

This work will be published in detail elsewhere.

I am indebted to Dr. C. G. Johnson and Dr. J. S. Kennedy for reading this communication in draft.

Bruce Johnson

Department of Entomology,
Rothamsted Experimental Station,
Harpenden, Herts.
Jan. 26.

[1] Müller, H. J., *Züchter*, **23**, 176 (1953).
[2] Moericke, V., "Zur Lebensweise der Pfirsichlaus (*Myzodes persicae* Sulz.) auf der Kartoffel", thesis, Univ. of Bonn (1941).
[3] Müller, H. J., and Unger, K., *Züchter*, **22**, 206 (1952).
[4] Kennedy, J. S., *Nature*, **165**, 1024 (1950).
[5] Kennedy, J. S., and Booth, C. O., *Ann. App. Biol.*, **38**, 25 (1951).
[6] Kennedy, J. S., and Booth, C. O., *Ann. App. Biol.*, **37**, 451 (1950).
[7] Johnson, Bruce, *Nature*, **172**, 813 (1953).

The Marshes of the Medway Estuary in Romano–British Times

The view has long been held that the Romano–British pottery and clay fire-bars which occur at various levels in the Scrobicularia Clay (that represents the bulk of the estuarine deposits which compose the marsh) constitute the output and appurtenances of contemporary potters' kilns which had been sited somewhere on the marsh.

The makers' stamps on the pottery cover a period ranging from the middle of the first century A.D. to the third quarter of the second century; though the greater number of the stamps fall within the Hadrian–Antonine phase, namely, between A.D. 117 to A.D. 161.

The present Ordnance Survey maps (scale 6 in. to 1 mile) of the area in question set across many of the saltings the following legend: "Roman Potteries (Site of)". Indeed, that of "Kent" (Sheet XX, N.E. Edition, 1908) shows no less than four such sites.

As the result of twenty-five years study of the deposits of the Upchurch Marsh, I write to suggest that this area could not possibly have supported a Romano–British pottery-making industry. The evidence upon which this suggestion is founded is two-fold—one geological, the other archæological. There is overwhelming proof that shortly after the commencement of the second century A.D. the sea had obtained complete control over the whole district and that Scrobicularia Clay had been universally deposited to the level of 5 ft. above O.D.

At this stage Romano–British man occupied the intertidal surface of the marsh-clay for the purpose of making salt. This industry is reflected in the occurrence over widespread areas of a specific deposit containing briquetage, clay fire-bars which were required for the process of salt-making, broken pottery and animal bones.

Over this accumulation of refuse—which varies in thickness from 6 in. to 3 ft.—the sea continued its deposition of marsh-clay up to a height of 11 ft. above O.D., which forms the highest level of the present-day salting surface.

A detailed description of the various archæological horizons which occur in these estuarine deposits will be furnished in a paper to be read later in the year.

J. P. T. Burchell

Falcon Cottage, Fawke Common,
Sevenoaks, Kent. Jan. 16.

Zoological Nomenclature

Notice is hereby given that the International Commission on Zoological Nomenclature has under consideration the following case involving the possible use of its plenary powers: *Caenisites* Buckman, 1925 (Class Cephalopoda, Order Ammonoidea), proposed suppression of. Full particulars of this case are given in Part 12 of volume 6 of the *Bulletin of Zoological Nomenclature*.

Any comments on the above case should be sent to me as soon as possible and, in any event, should be dispatched in time to reach me not later than August 26, 1954, when voting on this case will begin.

Francis Hemming
(Secretary to the International Commission on Zoological Nomenclature)

28 Park Village East,
Regent's Park, London, N.W.1.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Sunday, May 2—Friday, May 7

SOCIETY OF DAIRY TECHNOLOGY (at the Northern Counties Hotel, Portrush, Co. Antrim, Northern Ireland)—Summer Meeting.

Monday, May 3

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. T. E. Armstrong: "Northern Sea Route".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION AND FATS AND OILS GROUP (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "The Fats: a Story of Nature's Art".

Tuesday, May 4

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Annual General Meeting; Mr. D. W. Morris, Mr. W. G. Shaddick and Mr. E. W. Thurlow: "Short-Wave Directional Aerial Systems".

UNIVERSITY OF LONDON (in the Metallurgy Theatre, Imperial College of Science and Technology (Royal School of Mines), Prince Consort Road, London, S.W.7), at 5 p.m.—Prof. P. G. Kihlstedt (Stockholm): "The Economical Adaptation of the Beneficiation Processes". (First of four lectures on "Some Important Points in the Utilization of Low-Grade Ores by Mineral Dressing". (Further Lectures on May 6, 10 and 11.)*

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (in the Lecture Theatre of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by a discussion on "Corrosion and Design".

Wednesday, May 5

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 11 a.m.—Symposium on the "Golgi Apparatus".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Commander C. G. Mayer: "Colour Television".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Commandant G. S. Houot: "13,000 Feet Under the Sea".

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. R. Partington: "Some Aspects of Seventeenth-Century Chemistry". (Further Lectures on May 7 and 10.)*

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. P. M. Ratcliffe: "Microwave Measuring Equipment".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, May 6

LABORATORY ANIMALS BUREAU (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 10.45 a.m.—Symposium on "The Design of Animal Houses".

PHYSICAL SOCIETY, OPTICAL GROUP (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. R. H. Kay: "A Spectrophotometer for Estimating Ozone in the Atmosphere"; Mr. D. P. Feder: "Optics at the Bureau of Standards".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. H. Quastel, F.R.S.: "Soil Metabolism" (The Leeuwenhoek Lecture).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Peter Scott: "A Population Study of the Pink-footed Goose" (illustrated by a film taken in Iceland). Dr. W. J. L. Sladen will give a preliminary report of the flora of the area, illustrated with coloured slides.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. F. S. Collier: "The Forest Resources of the Colonial Territories and their Management".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Dr. R. H. Manske: "The Story of the *Iso*Quinoline Alkaloids" (Centenary Lecture).

SOCIETY FOR VISITING SCIENTISTS, LTD. (at 5 Old Burlington Street, London, W.1), at 7.45 p.m.—Discussion Meeting: "World Population —Views from Brazil, India and the United States". Chairman: Prof. L. Dudley Stamp, C.B.E. Speakers: Prof. H. O'Reilly Sternberg, Prof. George Kuriyan and Prof. George B. Cressey.

Thursday, May 6—Saturday, May 8

INSTITUTION OF CHEMICAL ENGINEERS, CHEMICAL ENGINEERING GROUP of the SOCIETY OF CHEMICAL INDUSTRY (joint conference with the ROYAL INSTITUTION OF ENGINEERS (Chemical Engineering Group) OF THE NETHERLANDS and the ROYAL NETHERLANDS CHEMICAL SOCIETY (Section for Chemical Technology, at Koninklijk Institut voor de Tropen, Mauritskade, 63, Amsterdam))—Conference on "Oxidation Processes".

Friday, May 7

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the MICROCHEMISTRY GROUP of the SOCIETY OF PUBLIC ANALYSTS, in the Zoology Lecture Theatre, The University, Reading), at 7.45 p.m.—Symposium on "Microchemical Methods in Biochemistry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. W. H. Thorpe, F.R.S.: "The Analysis of Bird Song".

Saturday, May 8

NUTRITION SOCIETY (in the Lecture Theatre, Department of Biochemistry and Physiology, The University, Glasgow), at 11 a.m.—Symposium on "Nutrition and the Liver". Chairman: Prof. J. N. Davidson.

SOCIETY FOR ANALYTICAL CHEMISTRY, WESTERN SECTION (at the Technical College, Newport, Mon.), at noon—Inaugural Meeting. Dr. D. W. Kent-Jones: "Alcohol Determination and its Medico Legal Aspects".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

NUCLEAR POWER ENGINEER (with a degree in physics or electrical engineering, and a knowledge of atomic physics, thermodynamics and metallurgy, and good practical experience), to organize and lead a new branch of the Chief Engineer's Department, which initially will be engaged on design studies of thermal reactors and the conversion of the liberated heat into electricity, and later will be required to design, construct and operate nuclear power stations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting AE/476 (May 5).

ASSISTANT LECTURER (graduate or about to graduate, and with special qualifications in palæontology and stratigraphy) IN GEOLOGY—The Registrar, King's College, Strand, London, W.C.2 (May 8).

LECTURER IN THE DEPARTMENT OF GEOLOGY AND MINERALOGY—The Secretary, The University, Aberdeen (May 8).

LECTURERS OR ASSISTANT LECTURERS IN CIVIL ENGINEERING OR SURVEYING, PHYSICS, VETERINARY MEDICINE AND PHARMACOLOGY, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 9).

ASSISTANT LECTURER IN PHYSICAL-ORGANIC CHEMISTRY, and a LECTURER IN THEORETICAL PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 10).

LECTURER (with an honours degree in chemistry, and experience in industry, teaching or research) IN CHEMISTRY—The Principal, Wigan and District Mining and Technical College, Wigan (May 10).

BIOCHEMIST to work on the proteins of eye tissues with particular reference to pathological conditions—The Secretary, Nuffield Laboratory of Ophthalmology, Walton Street, Oxford (May 14).

CHEMIST/BACTERIOLOGIST (with an honours degree in chemistry or member of the Royal Institute of Chemistry, and preferably with waterworks experience) in the Christchurch laboratory of the West Hampshire Water Company—The Chief Engineer, West Hants Water Company, 21 Stour Road, Christchurch (May 17).

JUNIOR FELLOW IN APPLIED MATHEMATICS—The Registrar and Secretary, The University, Bristol (May 17).

SCIENTIST, Grade 3 (with an honours degree in mathematics or statistics) on the London Headquarters Staff of the Director of Scientific Control, for work which mainly consists of the design of experiments and the analysis of experimental data obtained by the Board's scientists in the coalfields—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/771 (May 17).

ASSISTANT LECTURER (with either a special qualification in connexion with the mechanical testing of metals or experience in the chemical aspects of metallurgy) IN METALLURGY—The Registrar, The University, Manchester 13 (May 22).

LECTURER IN AGRICULTURAL BOTANY at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 22).

LECTURER IN THEORETICAL PHYSICS—The Registrar, University College of North Staffordshire, Keele, Staffs (May 22).

RESEARCH FELLOW IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (May 22).

NUFFIELD RESEARCH FELLOW IN PHYSICS, a RESEARCH PHYSICIST, and a RESEARCH ASSISTANT, for work in connexion with the cyclotron and synchrotron programmes of the Nuffield Research Laboratory—The Registrar, The University, Birmingham (May 30).

LECTURER IN EDUCATION at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

LECTURER (preferably with qualifications in applied mathematics and/or engineering mathematics) IN MATHEMATICS, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, May 31).

LECTURER (with British university qualifications, or equivalent, and some experience in teaching geology in a University Department of Geology and Geography) IN GEOLOGY, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

READER IN APPLIED MATHEMATICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 31).

ASSISTANT LECTURER (graduate in physics, engineering or chemical engineering, and preferably with experience in the food industry)—The Registrar, National College of Food Technology, Cranwood Street, London, E.C.1.

BIOCHEMIST (with a good honours degree and preferably with some experience of microbiology) to collaborate in work of sulphur metabolism—Prof. C. Rimington, University College Hospital Medical School, University Street, London, W.C.1.

CHEMICAL ENGINEERS (with an honours degree in chemistry or chemical engineering, A.R.I.C., A.M.I.Chem.E. or equivalent, with at least three years industrial experience of chemical engineering) in the Department of Atomic Energy, Risley, to draw up flowsheets and to co-ordinate the experimental work of several large laboratories; to supply design offices with detailed information on processes and operations involved; and to appraise new or modified chemical processes associated with atomic energy—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 571.

GOVERNMENT CHEMIST (with a degree in agricultural chemistry, and a knowledge of soils and soil analysis) in Zanzibar, for duties which will include the general chemistry of agricultural products, a small amount of forensic work, analysis and survey of soil, routine analysis of coconut oil and mangrove bark—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.97/10/01.

LECTURER (with a degree in horticulture or horticultural botany) IN HORTICULTURE, in the Faculty of Agriculture, Makerere College, East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1.

METALLURGISTS (with H.S.C. (science) or equivalent, and preferably with experience in metallurgical laboratory work, including metallography) at the Royal Aircraft Establishment, Farnborough, for (*a*) Metallographic work on fatigue of metals with special reference to effects of different micro-structures; (*b*) Research on extrusion and metallography of aluminium and magnesium alloys involving new and interesting techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.236/54A.

METEOROLOGIST (Agricultural) (with second-class honours degree in physics or mathematics, or equivalent with seven years' experience as a professional meteorologist, and preferably with experience in tropical or sub-tropical countries), in the Gold Coast Local Civil Service—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.57/13/02.

PHYSICAL CHEMIST (preferably with experience in photochemical work) to undertake fundamental research on the photochemical tendering of fabrics—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

PHYSICIST (with an honours degree), for work which is concerned with the physical principles (excluding electronics) and incidental problems associated with the development and manufacture of scientific instruments—The Director, British Scientific Instrument Research Association Laboratories, "Sira", Southill, Elmstead Woods, Chislehurst, Kent.

SCIENTIFIC OFFICER (with first- or second-class honours degree, or equivalent, in mathematics or physics) at the R.A.F. Station near Oxford, for operational research duties in connexion with aerial photography—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.313/53A.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The British Civil Service 1854–1954. By Wyn Griffith. Pp. 32+4 plates. (London: H.M. Stationery Office, 1954.) 1*s.* net. [242

The Civil Service in the Constitution. By Prof. K. C. Wheare. (A lecture delivered before the University of London, on 16 February 1954, to commemorate the centenary of the Northcote-Trevelyan Report.) Pp. ii+34. (London: The Athlone Press. Distributed by Constable and Co., Ltd., 1954.) 2*s.* 6*d.* net. [242

Royal Institute of Chemistry. Register of Fellows and Associates at 31 October 1952. Pp. xx+594. (London: Royal Institute of Chemistry, 1953.) [242

National Institute of Agricultural Botany. Farmers' Leaflet No. 2 (Revised January 1954): Varieties of Spring Wheats and Spring Barleys. (Recommended lists for 1954.) Pp. 4. Farmers' Leaflet No. 8 (Revised January 1954): Varieties of Winter Wheats. (Recommended List for 1954.) Pp. 4. Farmers' Leaflet No. 9 (Revised January 1954): Varieties of Winter Oats and Winter Barleys. (Recommended List for 1954.) Pp. 4. Farmers' Leaflet No. 13 (January 1954): Varieties of Spring Oats. (Recommended List for 1954.) Pp. 4. Farmers' Leaflet No. 14: Cereal Quality. Pp. 4. Seed Growers' Leaflet No. 14: Growing Cereals for Seed. Pp. 4. (Cambridge: National Institute of Agricultural Botany, 1954.) [242

Open Boat Whaling in the Azores: The History and Present Methods of a Relic Industry. By Robert Clarke. (Discovery Reports, Vol. 26, pp. 281–354+plates 13–18.) (Cambridge: At the University Press, 1954.) 21*s.* net. [242

"The Engineer" Buyers Guide. 1954 Edition. Pp. 648. (London: "The Engineer," 1954.) 5*s.* [242

Department of Scientific and Industrial Research. Forest Products Research Bulletin No. 30: Mechanics of Sawing: Band and Circular Saws. By P. Harris. Pp. iv+30. (London: H.M. Stationery Office, 1954.) 1*s.* 6*d.* net. [242

"Question," Vol. 6, No. 2. (Spring 1954.) Edited by H. Westmann. (Springs of Action: Contributed by M. B. Foster, P. B. Medawar, K. B. S. Smellie and Otto Van Der Sprenkel.) Pp. ii+111–184. (London: Hammond, Hammond and Co., Ltd., 1954.) 3*s.* 6*d.* net. [242

Carnegie Trust for the Universities of Scotland. Fifty-Second Annual Report (for the year 1952–53). Submitted by the Executive Committee to the Trustees on 22nd February 1954. Pp. iv+72. (Edinburgh: T. and A. Constable, Ltd., 1954.) [242

Society for the Promotion of Nature Reserves. Handbook—1953. Pp. 48+1 plate. (London: Society for the Promotion of Nature Reserves, British Museum (Natural History), 1954.) [242

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1952. North Western Division. By G. Hoyle. Pp. ii+30+4 plates. (London: H.M. Stationery Office, 1954.) 1*s.* 9*d.* net. [242

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S.), No. 13, January 29, 1954: The Barnesmore Granite Complex, County Donegal. By G. P. L. Walker and G. P. Leedal. Pp. 207–244+plate 14. 8*s.* No. 14, January 26, 1954: The Garnetiferous Beds of the Leinster Granite Aureole and Their Small-Scale Structures. By J. C. Brindley. Pp. 245–262+plate 15. 5*s.* No. 15, January 25, 1954: Blood Copper Deficiency in Offaly Cattle. By B. J. Scrior, E. J. Sheehy, G. F. O'Sullivan and J. O'Donovon. Pp. 263–274. 2*s.* (Dublin: Royal Dublin Society, 1954.) [252

Other Countries

Province of Quebec: Game and Fisheries Department. Ninth Annual Report of the Biological Bureau, for the period November 1st, 1950 to April 1st, 1952. Pp. 552. (Montreal: Province of Quebec, Game and Fisheries Dept., 1953.) [162

Publications of the United States Naval Observatory. Second Series. Vol. 17, Part 2: Observations of Double Stars made with the 26-inch Equatorial of the U.S. Naval Observatory 1945–49. By U. S. Lyons and L. R. Wylie. Pp. 65–86. (Washington, D.C.: Government Printing Office, 1954.) [162

Department of the Army: Corps of Engineers. Beach Erosion Board. Technical Memorandum No. 43: On Ocean Wave Spectra and a New Method of Forecasting Wind-Generated Sea. By Gerhard Neumann. Pp. iii+42. (Washington, D.C.: Beach Erosion Board: Office of Chief of Engineers, 1953.) [242

Yale University Publications in Anthropology. Nos. 49 and 50: Excavations at Wari, Ayacucho, Peru. By Wendell C. Bennett. Pp. 126+12 plates. On the Excavation of a Shell Mound at Palo Seco, Trinidad, B.W.I. By J. A. Bullbrook. Pp. 114. (2 parts in one volume.) (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1953.) 3 dollars. [242

Bulletin of the American Museum of Natural History. Vol. 103, Article 2: Mating Behaviour Patterns in Two Sympatric Species of Xiphophorin Fishes. Their Inheritance and Significance in Sexual Isolation. By Eugenie Clark, Lester R. Aronson and Myron Gordon. Pp. 135–226+plates 1–9. (New York: American Museum of Natural History, 1954.) 1.50 dollars. [242

Records of the Botanical Survey of India. Vol. 16, No. 1: The Flora of Khandala on the Western Ghats of India. By Dr. H. Santapau. Pp. xvii+396+3 plates. 32 rupees; 49*s.* Vol. 16, No. 2: Studies in Indian Berberidaceae from Botanical, Chemical and Pharmaceutical Aspects. By Dr. R. Chatterjee. Pp. iv+86+7 plates. 9 rupees, 2 annas; 14*s.* 6*d.* (Delhi: Manager of Publications, 1953.) [242

Annual Report of the Director of Forestry. 1 April 1952 to 31 March 1953. Pp. 80. (Wellington, N.Z.: New Zealand Forest Service, 1953.) [242

National Art Gallery and Dominion Museum. Report of the Board of Trustees for the year ended 31 March 1953. Pp. 18. (Wellington, N.Z.: Government Printer, 1953.) [242

Smithsonian Miscellaneous Collections. Vol. 122, No. 7: The Geology of Chaco Canyon, New Mexico, in Relation to the Life and Remains of the Prehistoric Peoples of Pueblo Bonito. By Kirk Bryan. Pp. vi+66+11 plates. (Publication 4140.) (Washington, D.C.: Smithsonian Institution, 1954.) [242

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 34, No. 23: Some Mammals of Yemen and Their Ectoparasites. By Colin Campbell Sanborn and Harry Hoogstraal. Pp. 229–252. 35 cents. Vol. 34, No. 24: Amphibians and Reptiles of Yemen. By Karl P. Schmidt. Pp. 253–262. 15 cents. Fieldiana: Geology. Vol. 10, No. 16: Fresh-Water Limestone from the Torola Valley, North-eastern El Salvador. By Sharat Kumar Roy and Robert Kriss Wyant. Pp. 173–192. 50 cents. Fieldiana: Botany. Vol. 28, No. 3: Contributions to the Flora of Venezuela. From Ericaceae through Compositae. By Julian A. Steyermark and collaborators. (Publication 724.) Pp. ii+499–678. (Chicago: Chicago Natural History Museum, 1953.) [242

Smithsonian Institution: National Collection of Fine Arts. Catalog of American and European Paintings in the Gellatly Collection. Fourth edition. (Publication 4143.) Pp. 20+13 plates. (Washington, D.C.: Smithsonian Institution, 1954.) [242

New Zealand: Department of Scientific and Industrial Research. Apia Observatory, Apia, Western Australia. Magnetic and Meteorological Results for 1951. Pp. iv+114. (Wellington, N.Z.: Government Printer, 1953.) [242

41st Indian Science Congress, Hyderabad—Deccan, 1954. Section of Botany; Presidential Address: Origin, Development and Structure of Important Vegetable Fibres. By Dr. B. C. Kundu. Pp. 22. (Calcutta: Indian Science Congress Association, 1954.) [252

Indian Forest Bulletin No. 172 (New Series): Silviculture. An Investigation into Thinning Cycles for Young *Chir* (*Pinus longifolia*) at New Forest, Dehra Dun. By V. S. Krishnaswamy and G. S. Mathauda. Pp. ii+10. (Delhi: Manager of Publications, 1953.) 14 annas; 1*s.* 3*d.* [252

Fisheries Research Board of Canada. Bulletin No. 99: Artificial Freshets and Other Factors Controlling the Ascent and Population of Atlantic Salmon in the La Have River, Nova Scotia. By F. R. Hayes. Pp. iii+47. 60 cents. Bulletin No. 100: Spoilage Problems in Fresh Fish Production. By C. H. Castell. Pp. vi+35. (Ottawa: Queen's Printer, 1953 and 1954.) [252

Canada: Department of Agriculture. Annual Report of the Director of Science Service for the year ended March 31, 1953. Pp. 56+4 plates. (Ottawa: Queen's Printer, 1953.) [252

Arid Zone Programme. Directory of Institutions Engaged in Arid Zone Research. Pp. xi+110. (Paris: UNESCO; London: H.M. Stationery Office, 1953.) 1.50 dollars; 8*s.* 6*d.*; 400 French francs. [252

Scientific Reports of the Indian Agricultural Research Institute for the year ended 30th June, 1951. Pp. ii+120. (Delhi: Manager of Publications, 1953.) 4 rupees, 6 annas. 7*s.* [252

Royal Alfred Observatory, Mauritius. Result of Magnetical and Meteorological Observations. New Series, Monthly. Vol. 29, Parts 1–12. (Mauritius: Royal Alfred Observatory, 1950.) [252